FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 111
No. 2348
Registered at the G.P.O. as a Newspaper

DECEMBER 7, 1961
Offices: John Adam House, John Adam St., London, W.C.2

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BOTH
FERROUS
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A FEW OUNCES
UP TO
20 TONS
RING
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THE COMBINATION OF
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Dowlais has been famous in the Iron and Steel Industry for over 200 years

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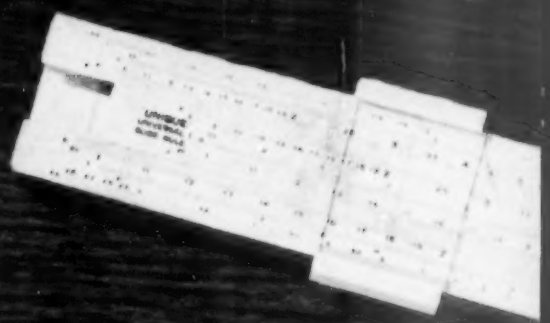

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in foundry formulae

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Heavy Corovit

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Fordath Complete Shell Sand Coating Units
Fordath Shell Moulding Units
Fordath Core Sand Mixers
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Silicon	0.08	0.08
Manganese	0.009	0.009

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	%		%		%
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				Tin	0.001

Sorelmetal is consistently uniform
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A

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"CUSTOMER! Here, give me that 'phone. Haven't I told you before, boy, customers are our life-blood.

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STERNOL **Sternocore Oil A**

- Is a time tested prime quality core oil.
- Gives cores an excellent skin finish.
- Has unusual tolerance to over baking.
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the pools

". . . and I might at that if a couple of teams I could mention were to buy themselves some decent centre forwards.

"Football is a funny game. One week a club is a world-beater and yet a few days later they can be licked to a frazzle by a team from a girls' school.

"Heaven help us if we carried on that sort of caper at AW. Customers don't want firms that are up one minute and down the next. When buyers come to a company with our reputation they expect—and get—a reliable performance. Fancy telling them that a load of pig wasn't up to specification because one of our furnacemen was off form!

"I reckon I'd get a coupon up every week if footballers were only half as consistent as the AW team."

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'Supplied to any specification at short notice'

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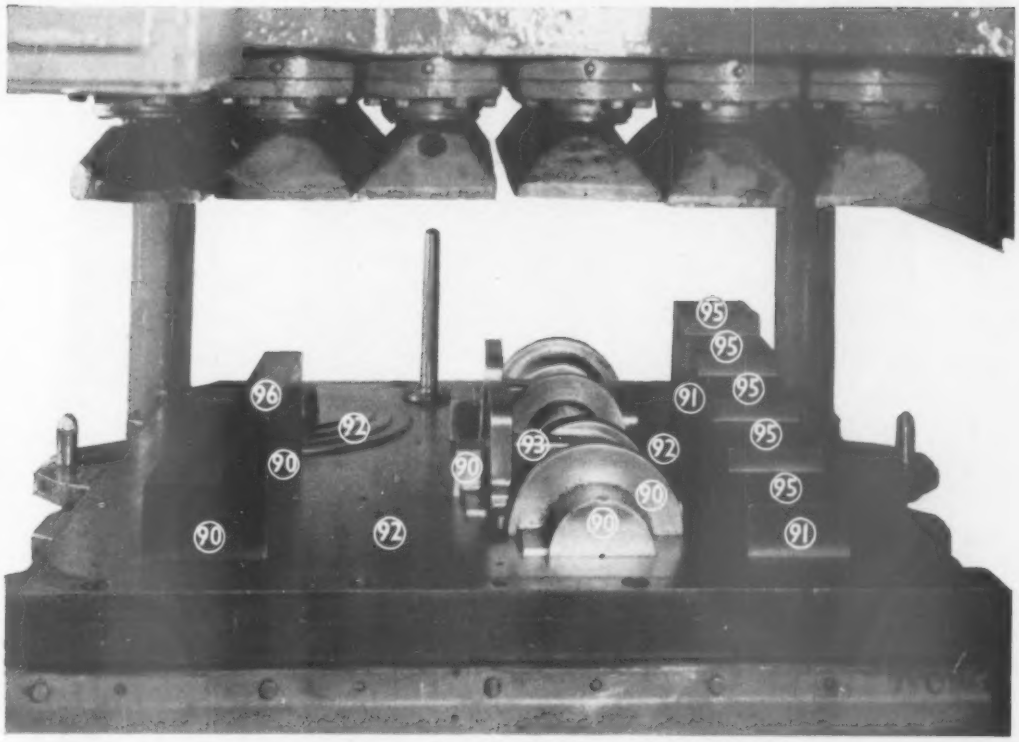


THE

HERMAN

Moldmaster

(PATENTED)

Check the hardness figures quoted, particularly on high and low spots and vertical walls. These illustrate the efficiency of the Moldmaster method of using oildraulic, self contouring multiple feet (4 x 4 in.)

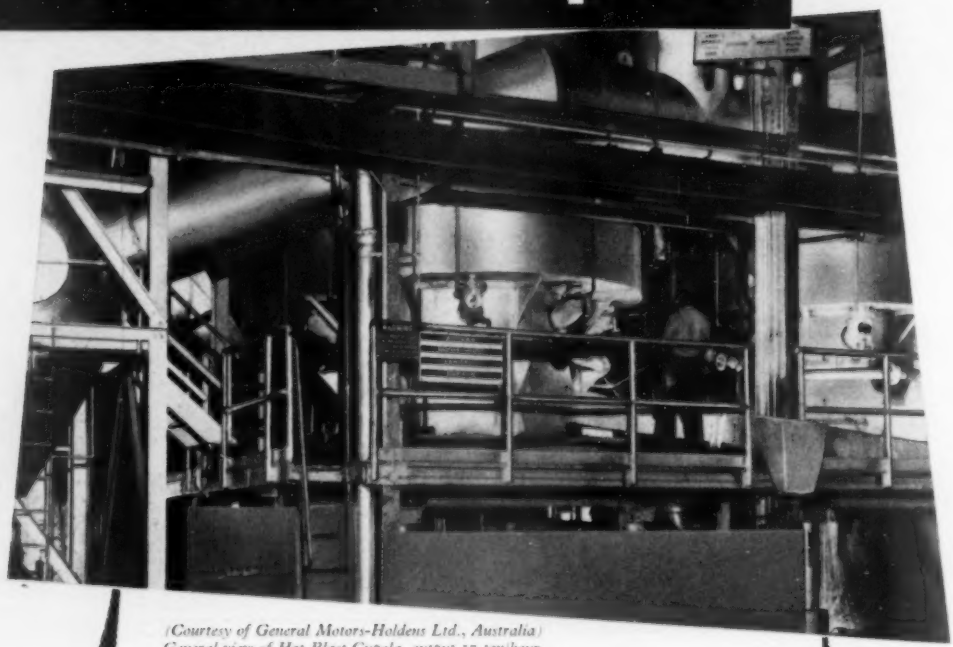
no jolting . . . no flat ramming

Built in England by

PNEULEC LIMITED, SMETHWICK, Nr. BIRMINGHAM

Escher

Hot Blast Cupola



(Courtesy of General Motors-Holdens Ltd., Australia)
General view of Hot Blast Cupola, output 17-ton/hour. Photograph shows (L. to R.) Combustion chamber, with air heater above, No. 1 Cupola and No. 2 Cupola. The water-cooled tuyeres can clearly be seen. This installation comprises two cupolas with common recuperator.

Four Escher H.B. Installations are now in operation, with outputs from 6 to 17-ton/hour. Three more, with outputs of 15 and 25-ton hour, are due to be started up later this year, including a British installation.

Principal advantages of the Escher H.B. system are:

- Starting from cold is simple and quick.
- No cleaning necessary.
- Up to 100% of top gas can be utilised, including blow-down period.
- Cupola can be operated with acid, basic or neutral slag.
- Simple, water-cooled, long-life tuyeres are used.
- Water-cooled jackets reduce lining and maintenance cost.
- Vertical recuperator lends itself to a compact and economical layout reducing installation cost.
- Cyclone-shaped combustion chamber, acts as dust-catcher.
- Less dust carried into the atmosphere.
- Higher metal temperature and reduced water-cooling losses.

FAME

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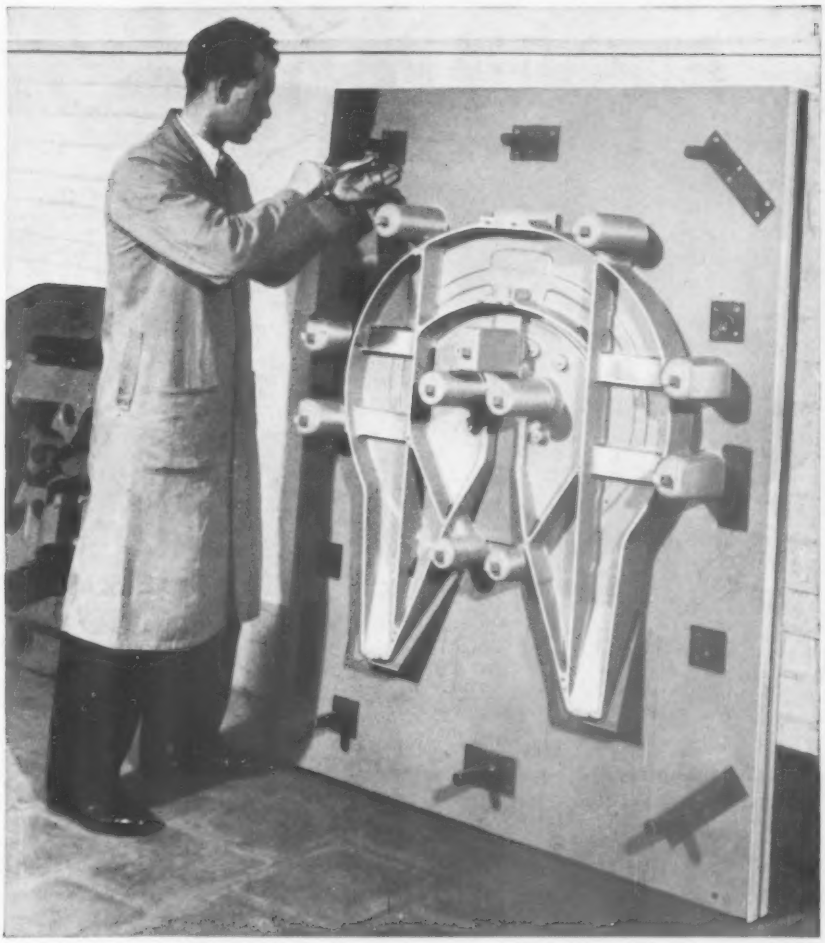

Standing up to it

This pattern for a fifth wheel steel casting required by Scammell Lorries Limited was made at the Leyland Motors Limited steel foundry at Farrington. It was made in Araldite casting resin because wood patterns could not withstand constant use on moulding machines. Araldite casting resins permit the speedy and economical production of any number of replica patterns, enabling the master pattern to be preserved. These duplicates are exact to size, as there is no shrinkage during setting, and no allowance for 'double reduction' is necessary. The patterns are tough, durable and not easily damaged, and do not deteriorate in store. Furthermore, modifications can easily be made, using the same materials. May we send you details of 'Araldite' epoxy resins for foundry patterns?

Araldite epoxy resins are used:—

for casting high grade solid electrical insulation

for impregnating, potting or sealing electrical windings and components

for producing glass fibre laminates

for producing patterns, models, jigs and tools

as fillers for sheet metal work

as protective coatings for metal, wood and ceramic surfaces

for bonding metals, ceramics etc.

ARALDITE EPOXY RESINS

Araldite is a registered trademark

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AP 651

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SHORT HEAD-ROOM. Light weight. Compact and highly efficient. Capacities from 1 ton to 20 tons.

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Faster . . . . Safer . .
More Manœuvrable . . .

A new concept in mechanical handling which replaces chains and 'C' frames. Can be used in gangways too narrow for fork-lift trucks—this means an increase of storage space of up to 50 per cent.

Available in a range of sizes and in capacities up to 5 tons.

RATCHET HOISTS

Incorporating a patented Overload Preventer giving greater security and safety to the operator, also reducing wear and saving cost of maintenance. A free - wheeling feature enables quick adjustment of unloaded chains.

BABY 60 ELECTRIC HOIST BLOCKS

BRITISH MADE. Patents Pending. 5 and 10 cwt. capacity. Light weight, compact and portable. Pushbutton control. Upper and lower overtravel limit switches. Supplies for any height of lift to suit requirements. Top hook suspension facilities attachment to travelling trolleys or girder clamps, etc.

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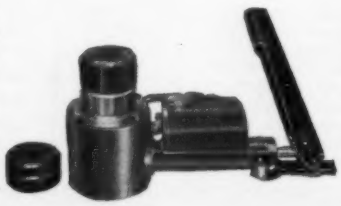
Large capacity for use in confined spaces. Swaying under load eliminated by large diameter providing easy adjustment of height. Capacities from 10 to 30 tons.



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Blocks built-in to Travelling Trolleys, giving reduced head - room. Capacities from 1 ton to 20 tons.

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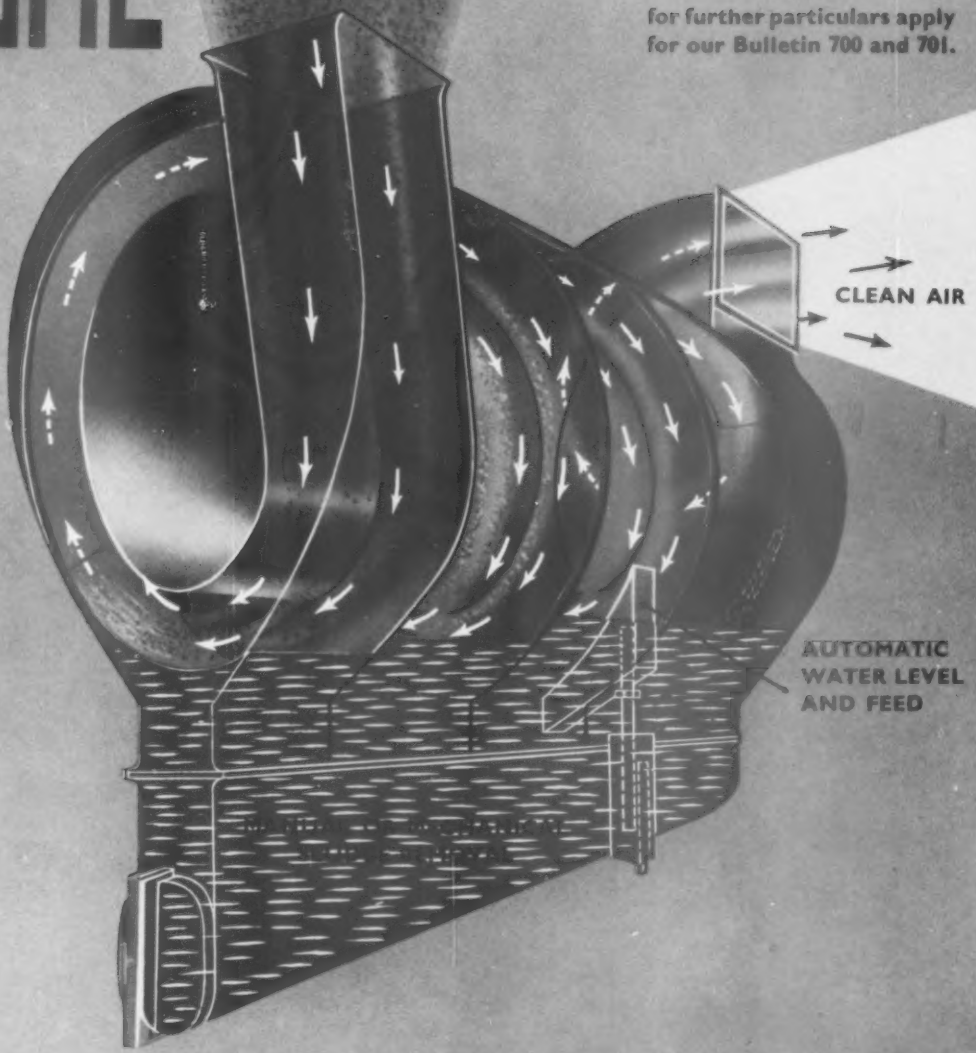

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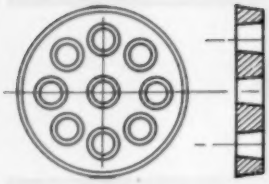
A3

Sterling make the box MIDCYL make the blocks

The illustration above is an un-retouched colour photograph taken while pouring was in progress at the new West Works of the Midland Motor Cylinder Co. Ltd. The boxes shown — inside dimensions 25¾″ × 37¾″ × 13″ × 13″ — operate in continuous moulding systems using Pneulec, Hermann Stationmaster Indexing Moulding Machines (squeeze cylinder dia. 36″) and produce cylinder blocks for the Automobile Industry at the rate of 80 moulds per hour.

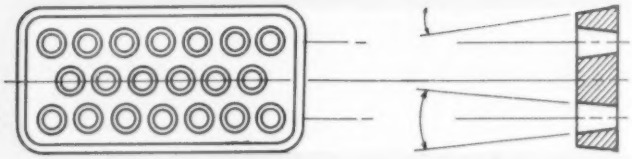
Sterling
MOULDING BOXES

STERLING FOUNDRY SPECIALTIES LIMITED, BEDFORD



go MODERN...go *Ceramic*

Ceramic STRAINERS



enable you to produce slag-free castings in all classes of iron including spheroidal graphite — steel and non-ferrous — to give:—

LESS SCRAP · CLEAN CASTINGS · HIGH METAL YIELD

Choose from our extensive range or let us make to your specification.

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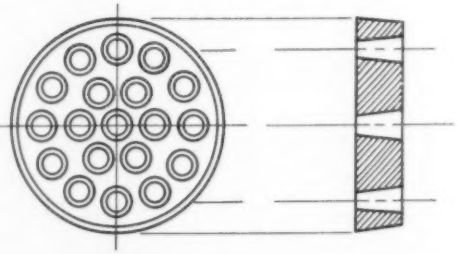

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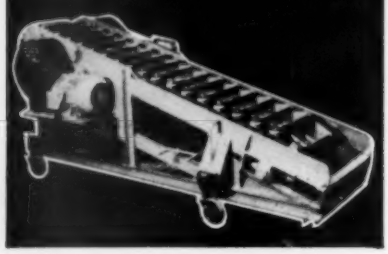
A large double strand machine producing alloy iron ingots.

A light machine suitable for small outputs of non-ferrous ingots.



Wherever metals require casting into ingots, we can provide a wide range of standard machines of proven reliability We also design and engineer casting machines to meet special conditions.

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A4

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Nº 8 Fulbond in synthetic sands

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The latest, largest, most powerful, ...

SPECIFICATION

Mould size (dimensions of sand block): 22" x 16".
Cope depth: 4". Drag depth: 4".
Squeeze pressure: 28,500 lbs.
Oil pressure: 1,250 p.s.i.
Piston Diameter: 5½".
Piston Stroke: 17⅛"
Total Weight (Machine, Pump, Panel): 7,000 lbs.

We invite your enquiries for our H.E.B. series and particularly for our brand new H.E.B.3 machine.

PATENTS APPLIED FOR IN ALL INDUSTRIAL COUNTRIES.

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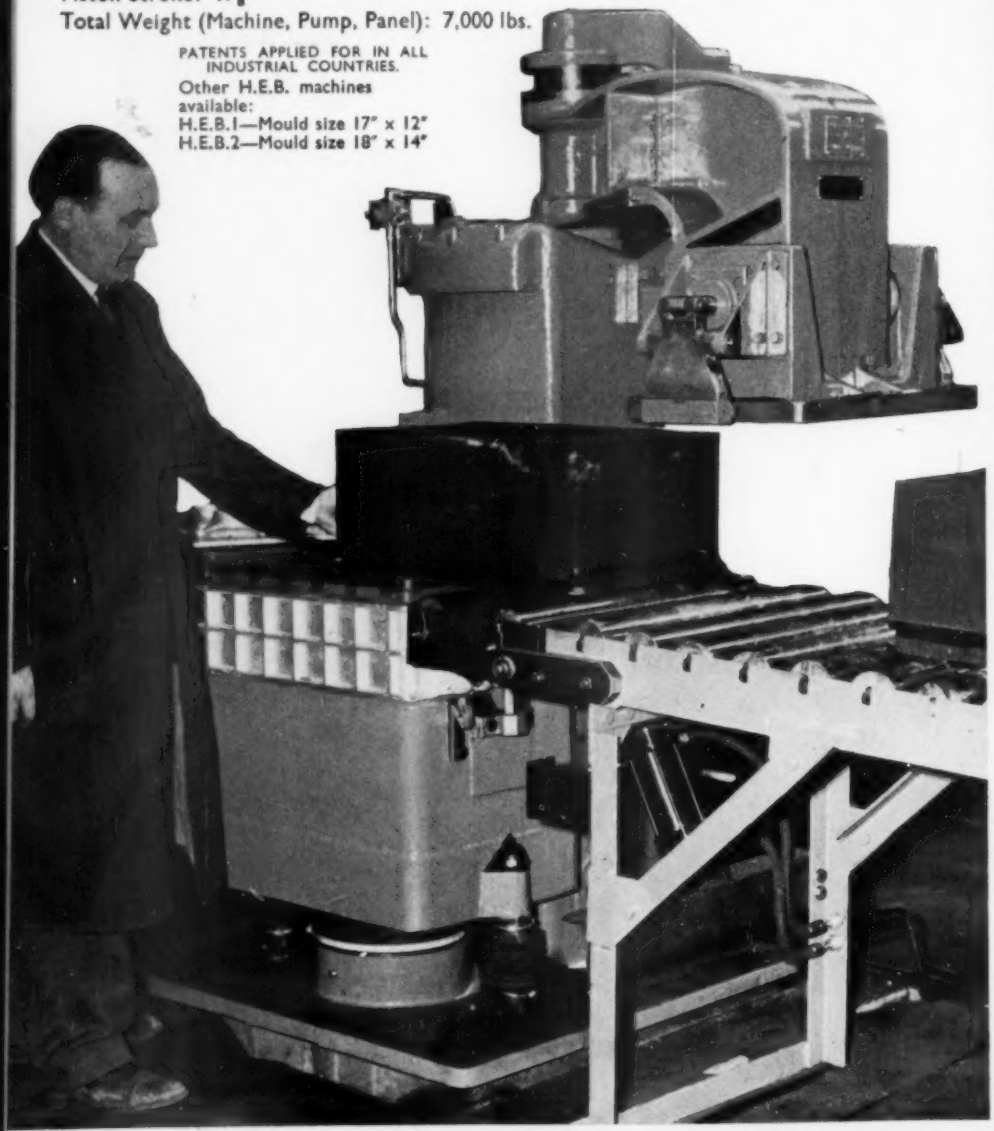

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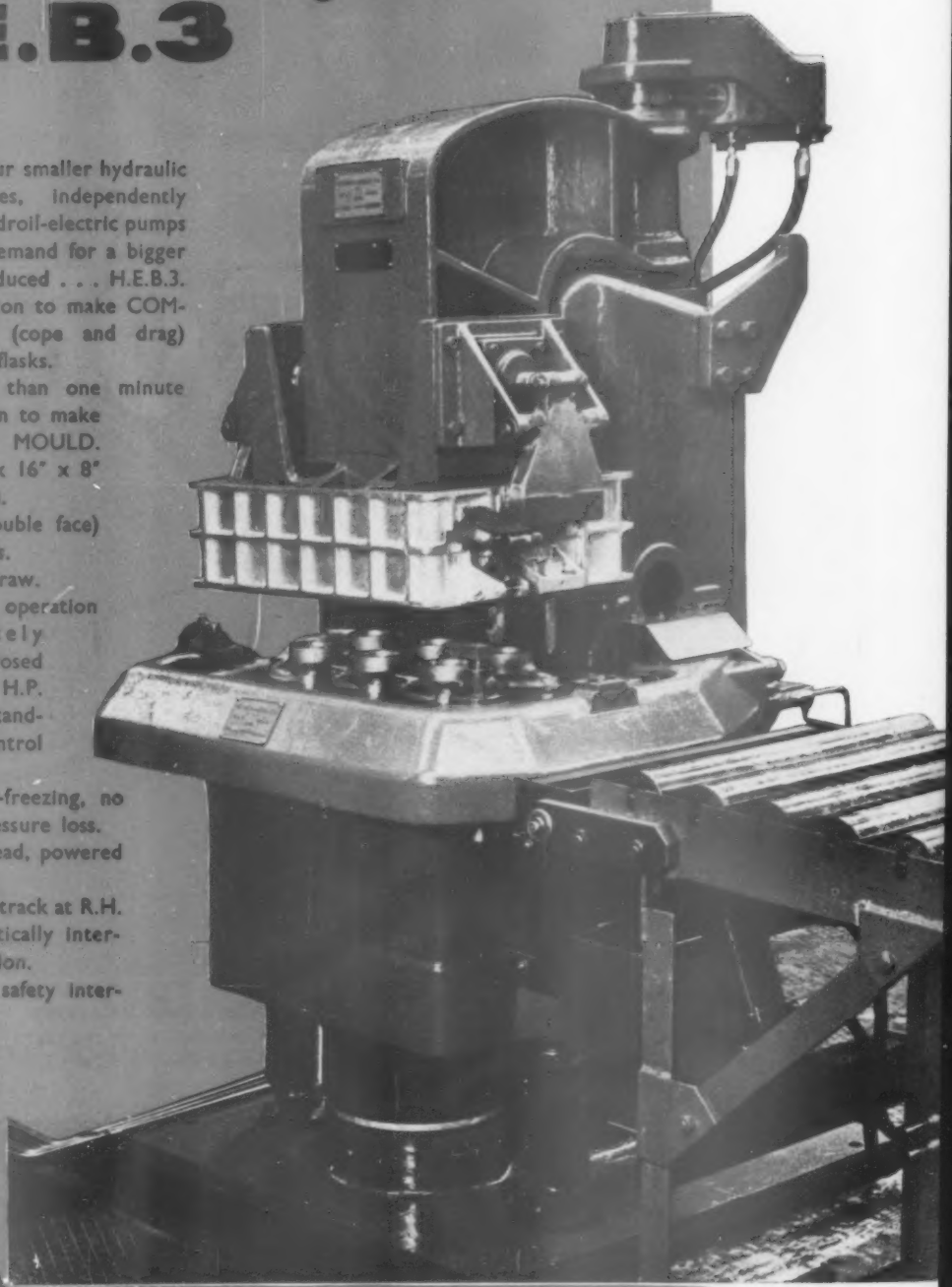
Boxless Moulding Machine

. H.E.B.3



The success of our smaller hydraulic Boxless Machines, independently powered with hydroil-electric pumps and the world demand for a bigger machine has produced . . . H.E.B.3.

One man operation to make COMPLETE MOULD (cope and drag) *without* boxes or flasks.

Production—less than one minute cycle for one man to make one COMPLETE MOULD.

Mould size: 22" x 16" x 8" (4" cope, 4" drag).

Pattern plate (double face) changed in *seconds*.

Adjustable slow draw.

All oil-hydraulic operation from separately mounted enclosed pump unit (7½ H.P. motor) and floor standing remote control panel.

Non-rusting, non-freezing, no pipe lines, no pressure loss.

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Roller strip-on to track at R.H. side with automatically interlocked lift-up section.

All movements "safety interlocked".

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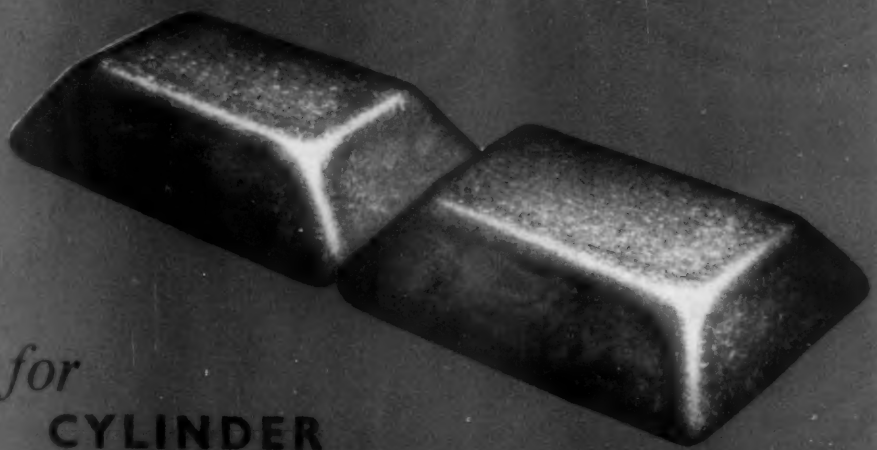
HIGH GRADE REFINED AND SPECIAL

PIG IRON



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UNIFORM HEATING

BETTER POURING

HIGHER QUALITY CASTINGS

In addition, Foxboro Systems are available for measuring, recording or controlling — Pressure, Humidity, Dewpoint, Temperature and many other variables.

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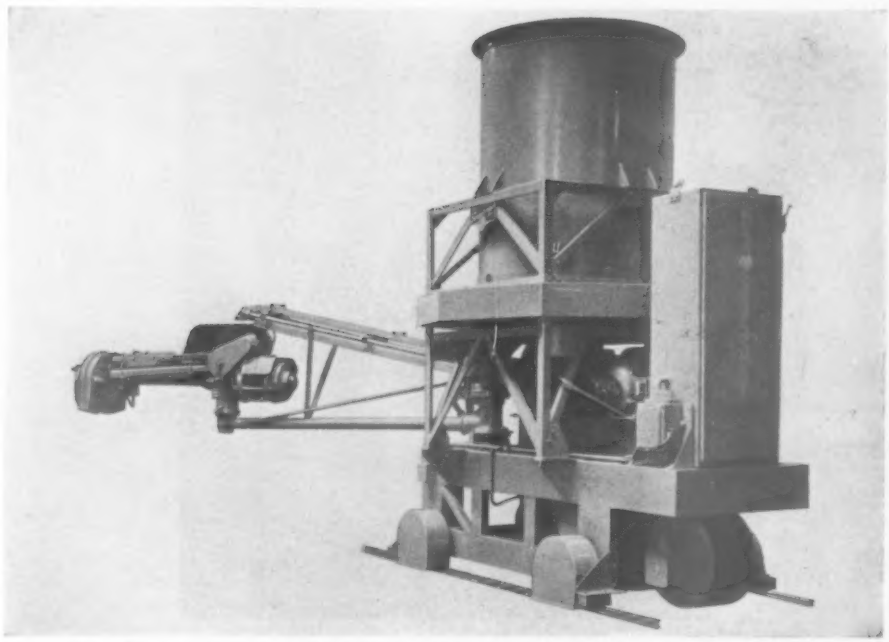
The Sandslinger



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Illustrated Brochure

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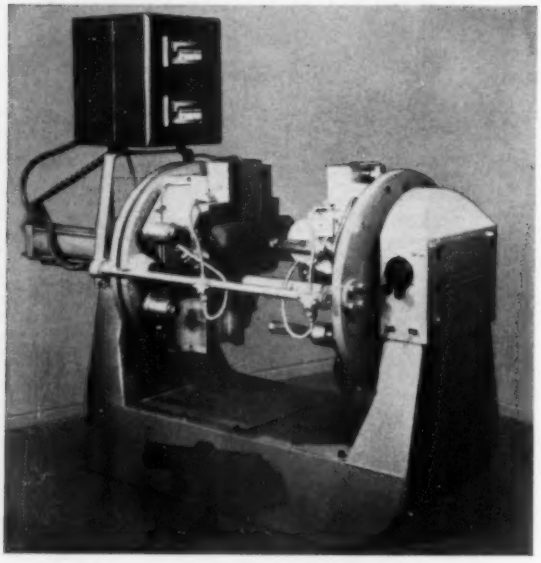
POLYGRAM MANIPULATORS FOR SHELL MOULD AND COREMAKING



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Full pneumatic operation from closing box to ejection of core.

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Temperature of each half of corebox electrically regulated within $\pm 5^{\circ}C$.

Can be used with existing core blowers or shooters.

These Manipulators can be incorporated into a number of multi-station Mould and Coremaking Plants.

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The Only British Specialists in Shell Moulding and Coremaking

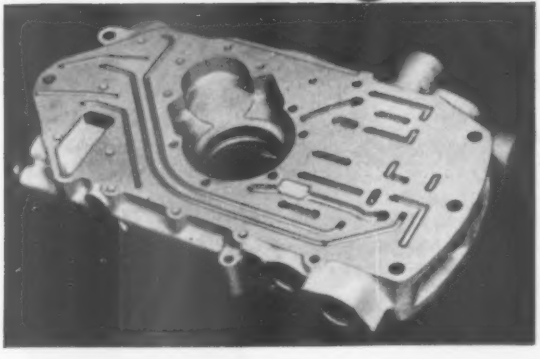
That's what I call PRECISION

0·100″ wall thickness with pin-point accuracy.

Precision is vital in the casting of high performance electronic equipment. That's why

STERLING METALS LTD.

chose to use a THOR Shell-Moulding resin. (Size of casting: 7½″ long × 10″ at widest point—wall thickness 0·100″)



"as cast" and not machine finished.

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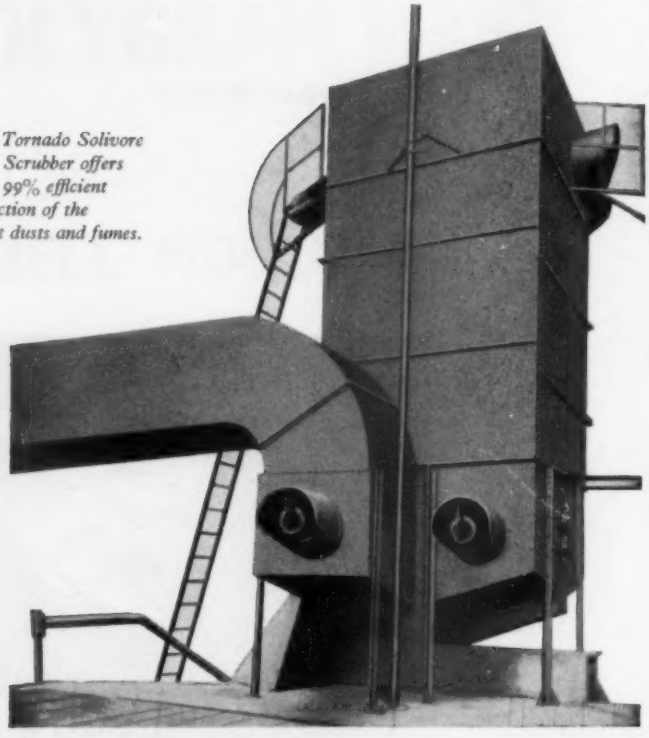

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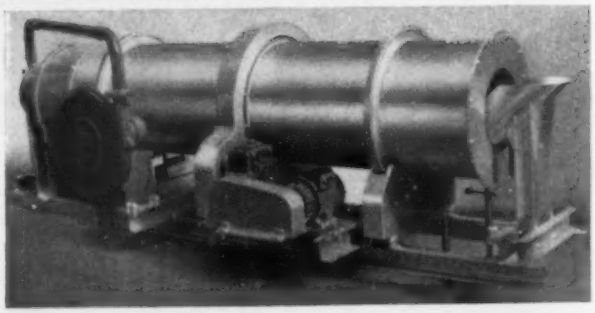

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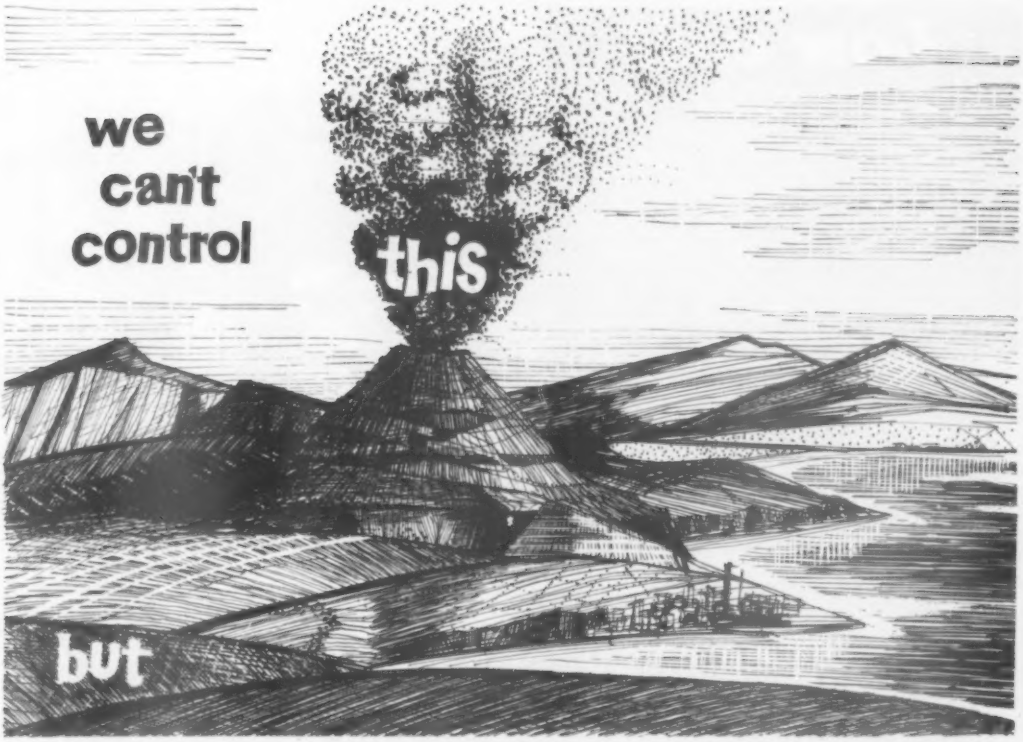

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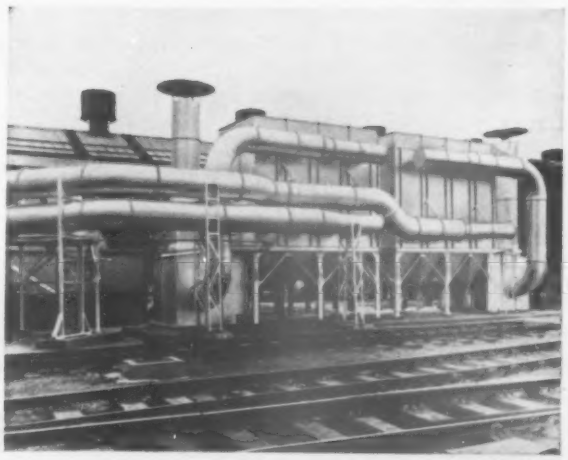

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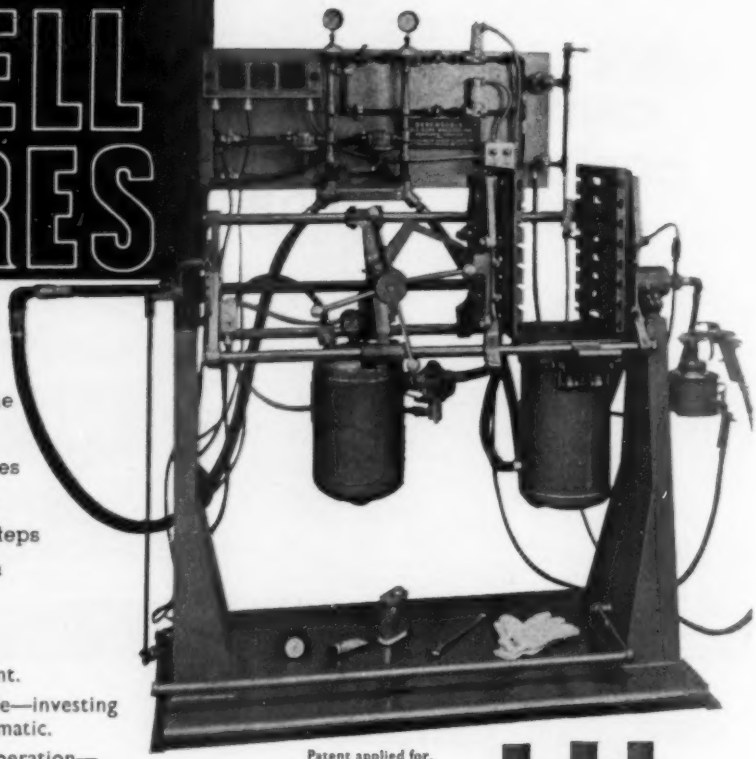

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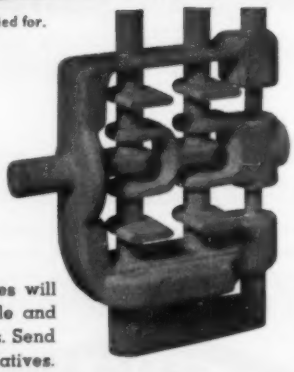

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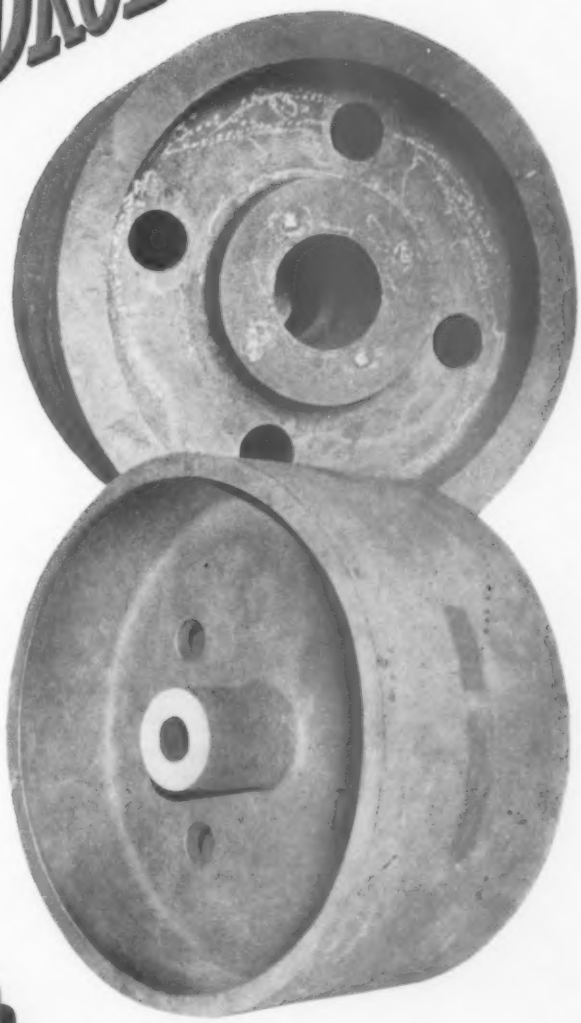

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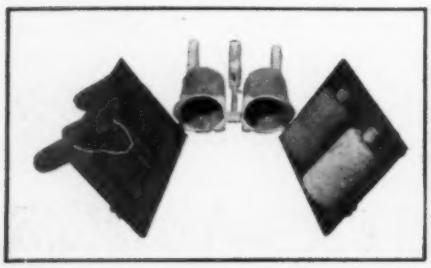

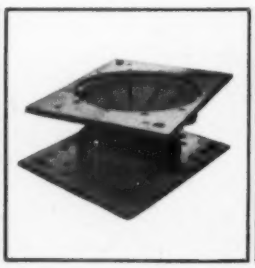

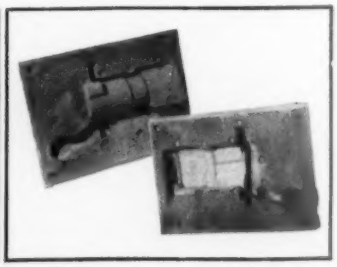

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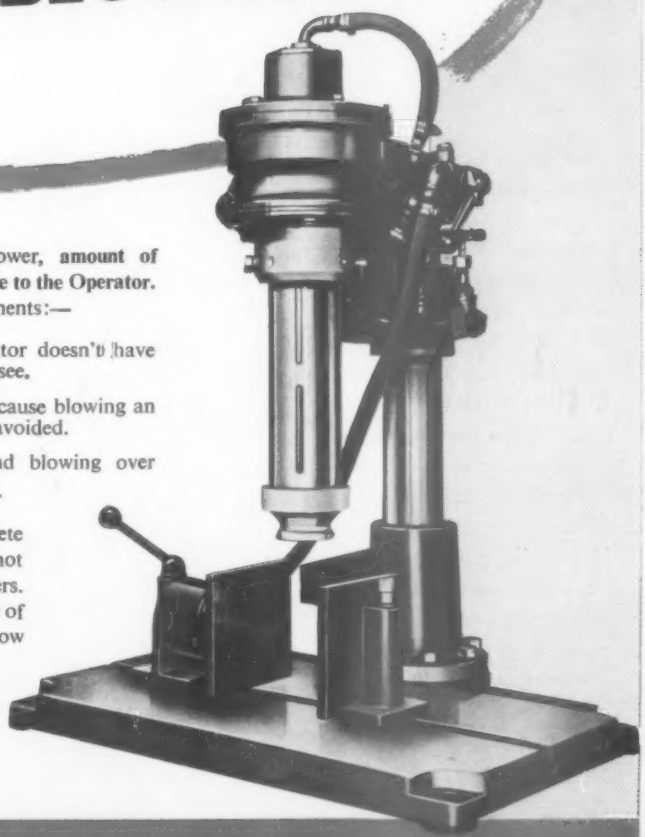

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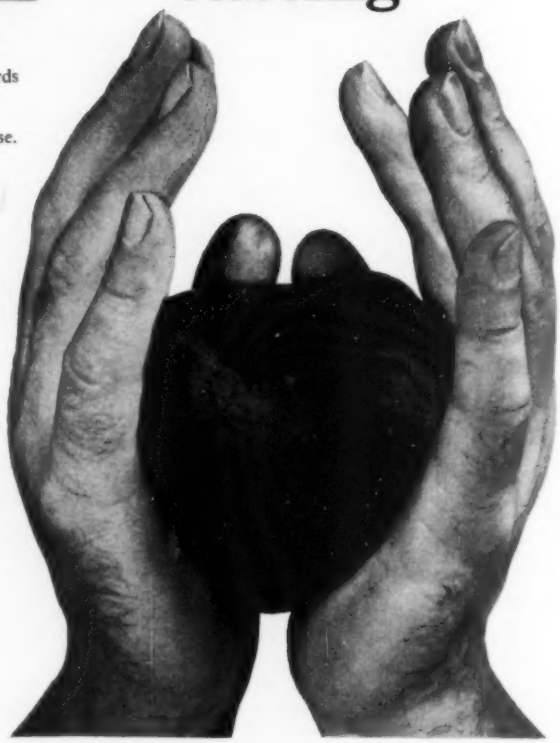

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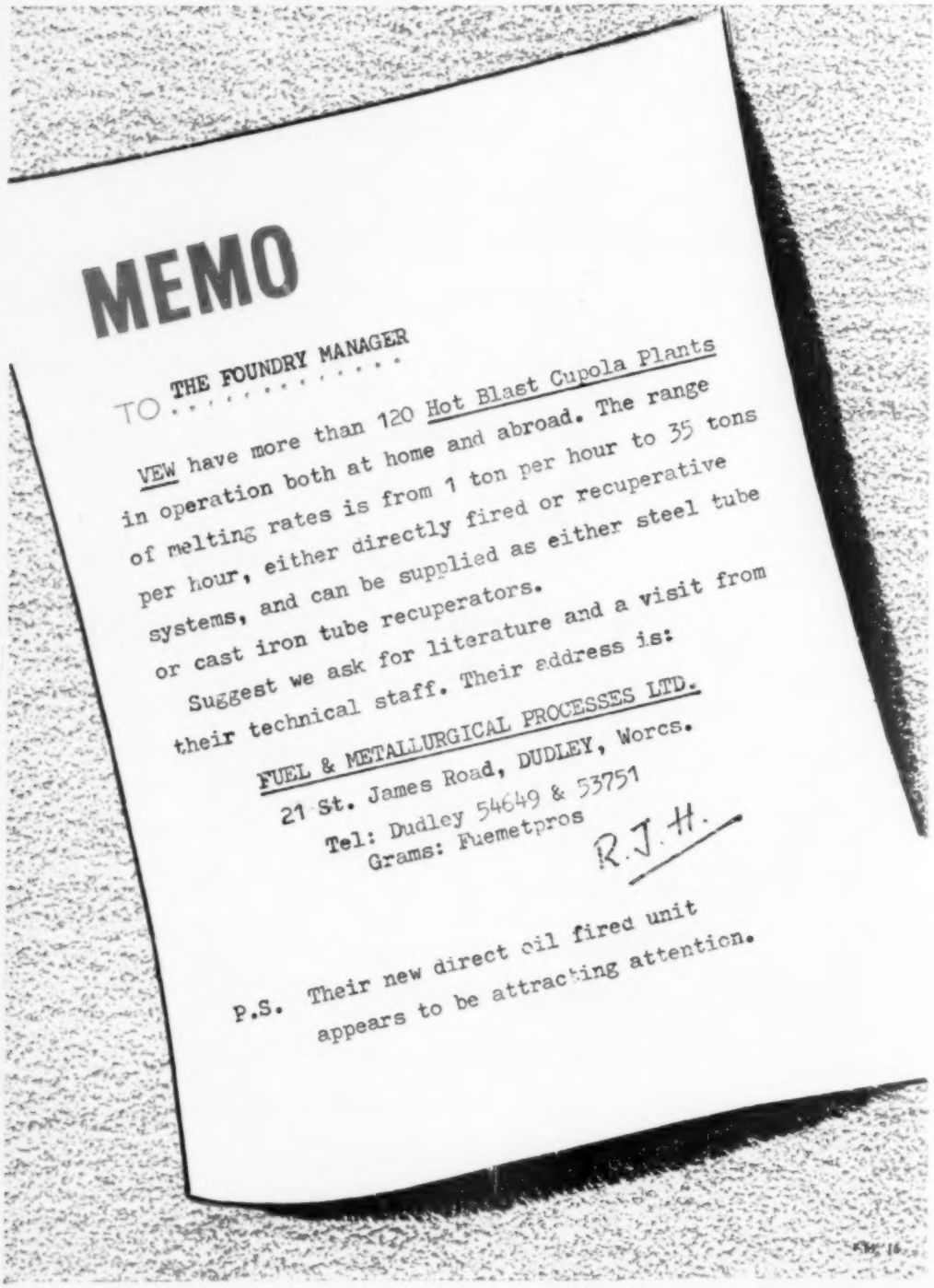

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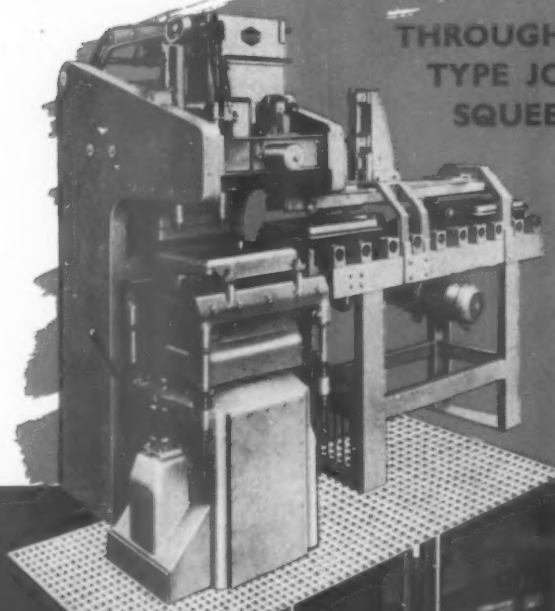

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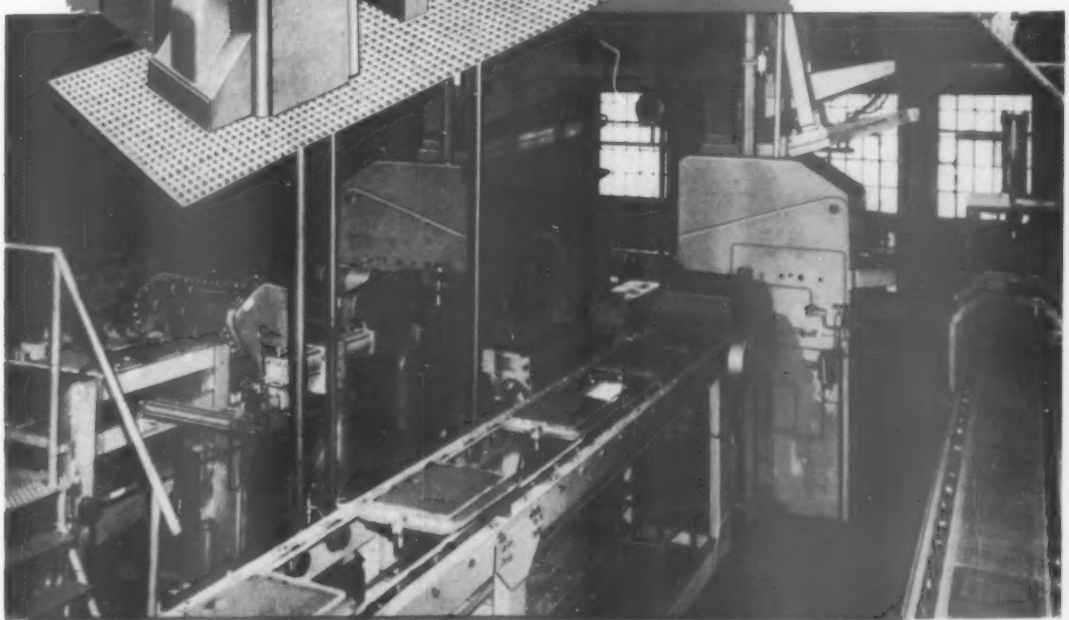

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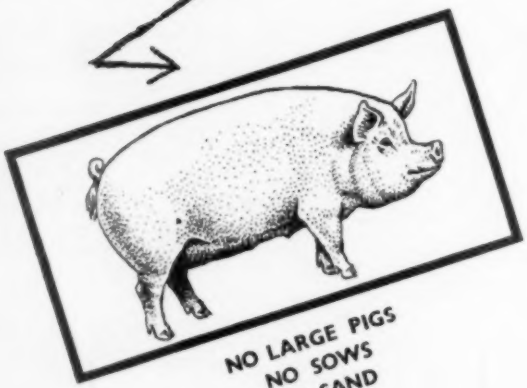

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Established 1902

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IRON & STEEL TRADES JOURNAL

Published each Thursday

Annual subscription: United Kingdom 52s.
Abroad 60s. *Payable in advance*

Editorial Director:
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The FOUNDRY TRADE JOURNAL is the official organ of the British Steel Founders' Association; Association of Bronze & Brass Founders; the Light Metal Founders Association; Foundry Trades' Equipment & Supplies Association; and the National Society of Master Patternmakers.

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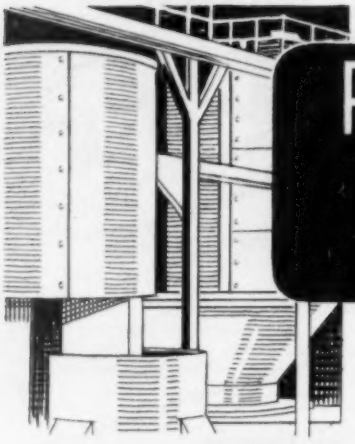

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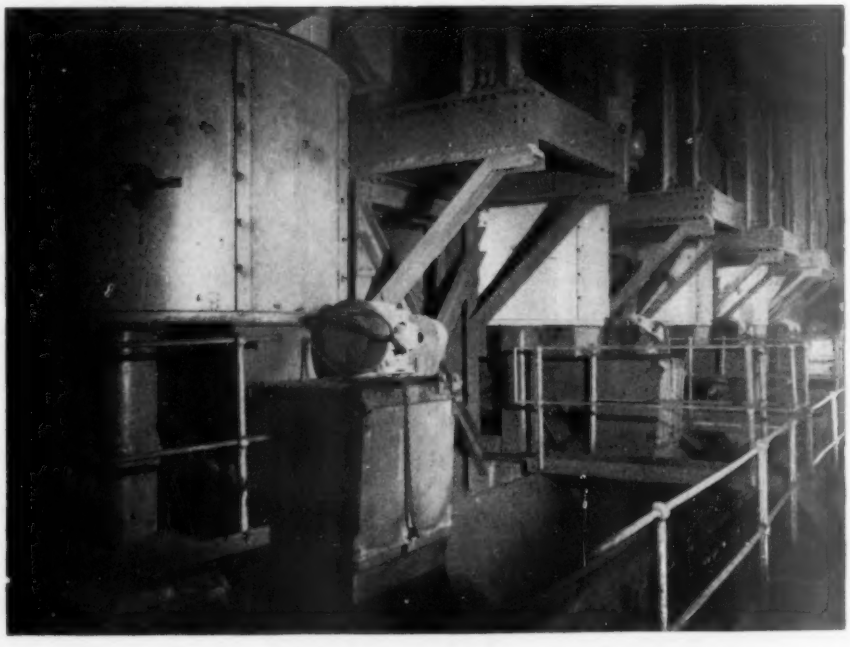

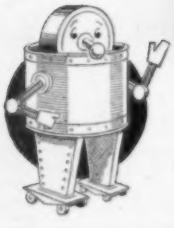

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FOUNDRY
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Vol. 111 December 7, 1961 No. 2348

Selling in Germany

The London School of Marketing, Limited, recently held a two-day seminar on how to sell in Germany. On the first day, consideration was given to the selling of consumer goods, whilst the next day was the turn of industrial goods and plant. The four lecturers all came from Germany. The opening lecture dealt with the economic situation and stressed that in spite of the large influx of German-speaking population from the East and Italians and others from the South, there was still an acute shortage of labour in their country. A few years' ago, the very prosperous building trade had had to be slowed down by Ministerial decree, in order to attract labour to other essential industries. Next, there was a talk on advertising media, and here it was learned that viewers were not keen on the introduction of " commercials " in television programmes. As there are no national daily newspapers, resort had to be made to the regional Press and magazines. The technical and trade Press, however, was the normal medium in Germany for the selling of industrial plant, it was stated. It was unusual for direct mailing to be used, as it was thought to be inefficient.

Quite the best contribution of the day was made by Mr. Alexis Joseph, a management consultant from Frankfurt. He gave a psychological analysis of several types of sales executive encountered during a normal business trip to Germany. The most awkward type was the man, who, after discussing the proposition at near top level, sends the representative down to the shops to talk to the foreman of the department ultimately concerned. Such an action is quite often puzzling to the sales engineer, but can usually be interpreted as meaning " nothing to-day, thank you "! Amongst the points raised—not without interest to the neophyte salesmen—was that every effort should be made to ascertain the title of the man interviewed and thereafter to use it. Moreover, it should be remembered that a wife in Germany acquires the academic distinctions of her husband. There is another class of German executive who likes to do the work of the sales engineer, namely, the *problem solver*. Thus, it is as well when talking of the efficiency of a machine to push a ball pen and piece of paper in front of this type of executive and allow him to do his own arithmetic. Finally, business representatives from the UK should use an English type of visiting card, and whilst it is most desirable that they should speak German, it is best that they are typical of their country.

Naturally, during the course of the day, there was a plethora of statistics submitted, but in many cases, these—especially when related to the cost of living—can almost be ignored, as they vary from town to town and province to province. Similarly, industrial costs vary as much on the Continent as they do here and in a final analysis, competition rests between only one or two firms. Thus, when selling in Germany, every effort must be made to see that the machines offered give complete satisfaction, because if not, the executive sanctioning the order loses " face " with his board and his colleagues alike. If delivery be held up by factors not controllable by the seller, the overseas customer should be kept constantly informed of the latest situation. In all negotiations, representatives must be meticulously careful to be punctual for an appointment and if this has been fixed by the buyer, useful information can be gleaned from the particular time stipulated! Most of what Mr. Joseph said was of quite general application to exporting to all countries.

Indian Metallurgical Technology

The August issue of the *NML Technical Journal*—journal of the National Metallurgical Laboratory, Jamshedpur, India—contains an article of particular interest to foundrymen. Entitled "Some Aspects of Silicate Bonding with and without CO_2," the authors, Mr. B. V. Somayajulu, Mr. J. Mohan and Mr. S. S. Bhatnagar, give results of comprehensive investigation work carried out on the hardening characteristics of Silicate Bonding with and without CO_2," the authors, assess the possibilities of effecting economies in the CO_2 Process of hardening moulds and cores by other gases, such as oxygen, nitrogen and atmospheric air. The authors compare the properties obtained in each case with those exhibited by conventional oil-sand cores. The authors carried out a comparative study of the strength values obtained by various methods and state that these showed that the strength values obtainable with silicate-bonded and dried specimens were comparable to, and in fact higher, than the values obtainable in the case of dried oil-sand specimens.

Addition of sucrose along with sodium-silicate imparted still higher values of compressive strength. Briefly, the conclusions drawn by the authors are as follow: (1) Zircon sand with a grain-fineness number of 124.5 (AFS) requires considerably lower percentages of sodium-silicate for giving high strength values, and increased additions of sodium-silicate to zircon sand impart high plasticity to the sand. (2) The effect of sand grain-fineness number is that the finer the grain-size, the higher is the compressive strength. (Coarse-grained sand develops high strength with prolonged gassing time, whereas fine-grained sand develops high strength when the gassing time is kept low.) (3) Any attempt to dilute the CO_2 by air, O_2 or N will lower the strength values of the sand mixtures. When air or O_2 is passed alone, the sand mix does not develop any strength at all. A further comparison of air, O_2 or N as dilutents shows that CO_2 when diluted with air gives better strength as compared with the values obtained with CO_2 plus N or CO_2 plus O_2. A progressive decline in strength can be expected with a decrease in the CO_2:air or CO_2:N, or CO_2:O_2 ratio.

In the experiments carried out, a gassing pressure of 30 mm. mercury and a gassing time of 30 sec. were found optimum to give compressive strength of the order of 100 to 150 lb. per sq. in. (4) When hardening the silicate-bonded sand by the application of heat alone, the binder requirement was more than when the sands were hardened by CO_2 or by a mixture of CO_2 with other gases. The optimum drying temperature and time were 200 deg. C. and 5 min. respectively, and it was found that a little water addition helped to improve strength characteristics of the sands on hardening. However, in the case of natural moulding sands, the addition of even appreciable amounts of water along with sodium-silicate does not impart adequate strength to the sand mixture. Finally, the authors state that the objection to using a moulding sand containing clay for silicate bonding is sustained by the investigations carried out.

Other subjects covered in this issue include "Research in the Metallurgical Industry," a lecture given at the National Metallurgical Laboratory by Mr. W. E. Bardgett (of the research and development department, United Steel Companies, Limited, Rotherham, UK); "Non-metallic Inclusions—their Quantitative Extraction from Steel," by Mr. D. S. Tandon and Mr. J. R. Gupta, and "Corrosion of Steam-turbine Blades," by Mr. K. P. Mukherjee, Mr. A. K. Lahiri and Mr. T. Banerjee.

Forthcoming Events

DECEMBER 11

Tyne Wear Metallurgical Society

Short lectures by three members on "Metallurgical Problems Encountered in their Work," 6.30 p.m., in the Metallurgy Department, King's College, Haymarket, Newcastle-upon-Tyne.

Institute of Metals

Scottish local section:—"Progress in the Electron Theory of Metals," 6.30 p.m., at the Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, C.2.

DECEMBER 12

Institute of Production Engineers

Doncaster section:—"Continuous Casting," by G. Littlewood, 7 p.m., at the Technical College, Waterdale, Doncaster.

Institute of Metals

Oxford local section:—"Lattice Spacing Determination as a Tool in Metallurgical Research," by Prof. G. V. Raynor, 7.15 p.m., at the Cadena Cafe, Cornmarket Street, Oxford.

DECEMBER 13

Combustion Engineering Association

Scotland:—One-day meeting in the Royal Hotel, Union Street, Dundee: 10.30 a.m., discussion on "Operational Boiler Defects and Methods of Repair," opened by F. Mosley; 2.30 p.m., "Problem of Grit and Dust Emission," discussion opened by H. Westwood.

Institute of Production Engineers

Liverpool section:—"Production Engineer's Approach to Domestic-appliance Manufacture," by V. J. Adams, 7.30 p.m., at the Central Library, William Brown Street, Liverpool.

DECEMBER 14

Institution of Plant Engineers

Merseyside and N. Wales branch: "Overhead Equipment for Railway Electrification," by J. H. Leonard, 7.15 p.m., at the Exchange Hotel, Liverpool.

Institute of British Foundrymen

Lincolnshire branch:—Joint discussion with the authors of the papers: "Report of Sub-committee TS 49 of the Technical Council—Feeding of Castings," by A. Tipper, "Thoughts on Phosphoric Cast Iron," by R. V. Riley, and "Practical Observations on Mould Stability as a Factor in Controlling Soundness," by A. D. Morgan, 7.15 p.m., at the Technical College, Cathedral Street, Lincoln.

London branch:—"Feeding Non-ferrous Castings," by E. C. Mantle, 7 p.m., at the National Liberal Club, Whitehall Place, London, S.W.1. (Joint meeting with the London local section of the Institute of Metals.)

Southampton Metallurgical Society

"Fatigue," by T. R. G. Williams, 7.15 p.m., at Southampton University.

Institute of Metals

Sheffield local section:—"Metals in the Jewellery Industry," by Miss D. L. Pile, 7.30 p.m., at the Applied Science Building of the University, St. George's Square, Sheffield.

DECEMBER 15

Institute of British Foundrymen

Northampton section:—Annual dinner, 7.30 p.m., at the Hind Hotel, Wellingborough.

THE BROCKHOUSE ORGANIZATION announce that, as a result of the success of a single-storey primary school, exhibited by Great Britain at the 12th Triennale, held in Milan in 1960, the CLASP method of construction upon which it was built is now to be made available in Italy. The work of converting dimensional data to metric measurements modifying the system to suit local conditions, has been carried out by Costruzioni Modulari S.p.A., of Milan, a subsidiary company of Brockhouse Steel Structures, Limited, of West Bromwich, manufacturers of the special prefabricated steel framework, upon which the system is based.

Shaw Process . . .

. . . is this a Breakthrough in the Foundry Industry?

*By G. H. Found**

The following article delivered as a paper to the Shaw Process International Conference held in London earlier this year makes a strong case for the application of this precision-moulding method to grey iron. Inspired by the current stagnation of grey-iron founding in America the Author makes a brief assessment of its current relative position in the industry and relates its prospects directly to its ability to adapt itself to the demand for precision, finish and economy in the contemporary engineering field. Although springing from a rather different economic background from that holding in this country, the possible perspective, for the UK, of more intense European competition will no doubt make the possibilities suggested by the Author of great interest to British ironfounders.

An established requirement for a growing industrial economy is a progressive foundry industry. Every growth period in history has been made possible by unique and significant developments in the metalworking industry, of which the foundry industry is an important part. This was as much the case for the ancient transition from the Bronze Age to the Iron Age as it is to-day for the transition from the air age to the space age. This means that with regard to the technological progress each new stage in history has either been made possible on the one hand, or has been limited on the other, by the materials and processes of the metalworking industry. This includes in particular the foundry industry.

The following specific factors demonstrate the tie between American industrial economy and the foundry industry: (1) Foundry casting processes convert raw material to the shape of the finished parts in one step only. Foundry processes are thus potentially the least expensive and the shortest path between raw materials and end products. This is in contrast to fabricating with fastened-together, non-foundry, mill products (sheet, extrusions, and rolled shapes). Here a foundry operation is but the first of several steps from raw material to finished part. (2) Foundry processes usually permit fabricating the most complicated structures with the least number of operations that can be achieved in the shortest time. (3) The structural integrity of end products as castings is higher, because of the continuity of shapes with the least number of joins. Joins are usually the weakest link in a structure. (4) Between 45 and 55 per cent. of all castings produced in the US are purchased by the transportation industries. These industries are intensely concerned with reliability, maximum performance, minimum weight, and lowest cost. Castings offer the best combination in these respects. (5) Growing American industrial economy is constantly confronted with demands for higher-performance components at lower costs. Higher-performance parts are attained by the use of either higher-performance alloys or design improvements. In either case, foundry process improvements make alloy and design changes possible. (6) When economic pressures have dictated lower-cost end products, the foundry industry has responded with new or improved processes to meet these needs.

In short, it is apparent that there is a direct cause-and-effect relationship between the needs of a growing industrial economy and the progressiveness of the foundry industry. Thus, whether it be from the standpoint of keeping up with the new needs of industry or from the standpoint of fulfilling its ultimate destiny for success with its potentially lowest-cost, most-versatile processes, the foundry industry will continue to be as important as its inherent skills permit.

State of the Industry

Foundry statistics which are disappointing when compared to the job to be done, reveal the following facts: (1) The number of sand foundries in

* Dr. Found is in charge of metallurgical engineering at Arthur D. Little, Inc., of Cambridge, Massachusetts, USA.

TABLE 1.—*American Despatches of Ferrous Castings (average monthly figures in thousands of tons)*

Year.	Grey Iron.	Malleable.	Steel.
1945	710	59	145
1946	770	56	107
1947	950	67	122
1948	980	70	133
1949	810	54	94
1950	1,000	70	110
1951	1,080	81	153
1952	980	69	144
1953	1,080	72	137
1954	860	61	88
1955	1,100	82	114
1956	1,030	71	144
1957	940	64	132
1958	770	49	83
1959	920	68	105
1960	865	61	104

Source: Metals Statistics, 1959, and *Survey of Current Business*, March, 1960, March, 1961.

FIG. 1.—*Miscellaneous group of dies made by the Shaw Process, mainly for decorative and consumption goods applications.*

the United States has been decreasing over the last eight years at four per cent. per year. In addition, many foundries have diverted their efforts toward diversification into end products involving castings. This is a defensive effort to sustain profit margins, and in some instances to prevent the closing down of their foundry operations completely. (2) The average profit levels of the foundry industry are the *second lowest* of any industry in the United States. This fact can come only from excessive competition where foundries are constantly bidding mainly *to take* business from other foundries, rather than developing new, lower-cost, higher-performance processes by which to bring new business into the industry. Competitive inbreeding of this type could be mistaken as a sign that the industry has reached "old age." This cannot be the case, however, in view of the potential importance of foundry processes, as already pointed out. Such erroneous generalization is opposed by developments in many important specific areas. (3) Unfortunately, these adversities have reduced the attractiveness of the foundry industry for young, trained creative people and for new investment capital, both of which are needed to stimulate enterprise in any industry. (4) The most seriously threatened parts of the foundry industry are those associated with sand techniques and iron. In the former instance, the process is inherently labour intensive, which makes it vulnerable in high-labour-cost regions and to pressure- and gravity-die-casting. In the latter instance, iron has not been amenable to the lower-labour-cost castings processes and faces severely curtailed markets despite being by far the lowest-cost raw material to cast.

In recent years, ferrous casting technology has not kept pace with the requirements of industry for cheap precision-made parts. Other metal-working approaches—forging, pressing, welding, and powered-metal sintering—have come into greater prominence. Moreover, as the new precision techniques of gravity- and pressure-die-casting cannot easily be used for the ferrous metals, aluminium is taking over some important markets. The demand in the US for ferrous castings has

shown no growth for well over a decade (see Table 1).

Major attention has been devoted recently to the development of precision-casting methods that are applicable to iron and that will provide a finished part at a cost competitive with that of other processes and other metals. Since a number of possible choices are available to producers of larger-volume parts, the selection of process and material is based primarily on cost factors.

Sources of Confidence

Those individuals who see new growth in the foundry industry come from three categories: (1) *The product design engineers:* These people frequently see foundry processes as the best route to structural consistency, reliability, and strong, efficient design by the use of thin walls, few joints, light weight; close dimensions, and intricate shapes. The constantly-increasing performance requirements in end-products are pressing the design engineers to their limits. They are confident that they will have more advanced foundry processes with which to do their job. They must, and this fact will create the effort necessary. (2) *The foundry-process engineers:* These men are confident they can continue to improve their process position with thinner walls, more intricate shapes, and more-consistent quality. They are on the lookout for the means and the new concepts by which to obtain the features that they recognize their customers are after. (3) *The industrial economists:* Although more removed from the processing details, these people know that the metalworking industry represents $157,000 million in the $510,000 million 1961 economy of the United States. They also know that castings represent about 15 per cent. of the metalworking industry. At the foundry level (leaving out machining, assembly, and end-product distribution costs), about $6,000 million worth of castings and casting equipment is despatched yearly in the United States. It is self-evident that foundries are going to do all they can to protect the business they presently have. It is equally evident, as the foundry industry demonstrates a renewed competitiveness with other processes in the metalworking industry, that tremendous potential growth exists. Indeed, the growth potential is larger than for any other industry in the country, since the metalworking industry is the largest single industry.

More Favoured Founders

It is quite clear that foundry products are in demand in lighter, more precisely dimensioned form. This is true for two reasons: (1) Lighter weight in major product components usually gives a "cascading" effect of lower costs elsewhere in the product and in its performance. (2) In addition, since material costs have become of relatively-major importance as the costs of fabricating have been reduced, the use of less material and less weight means a new horizon for cost savings. The availability of closer dimensional tolerances in the foundry casting also saves in subsequent machining costs. These interests in light weight, less material, thinner walls, closer dimensional tolerances, and smoother finishes at lower costs are going by default to the aluminium gravity- and pressure-die-casting industry, which now are vigorously growing sections of the foundry industry. Indeed, the aluminium die-casting industry is now tripling its production every five to six years. These trends have developed despite the fact that iron is the material more familiar to everybody; the sand casting process is the accepted means for highest-volume production, and iron is a far-less expensive raw-material. But these traditional advantages are offset by the fact that iron previously could not be cast to close tolerances by processes competitive with die-casting; it loses much of its initial lower-cost advantage in the raw form by its more-expensive traditional casting processes, and has not had the chance to show fully its weight-saving potentialities. In lieu of being able to procure thin, light walls in iron castings on a competitive basis, customers have been attracted to light or low-density metals (notably aluminium) for weight saving. As an added advan-

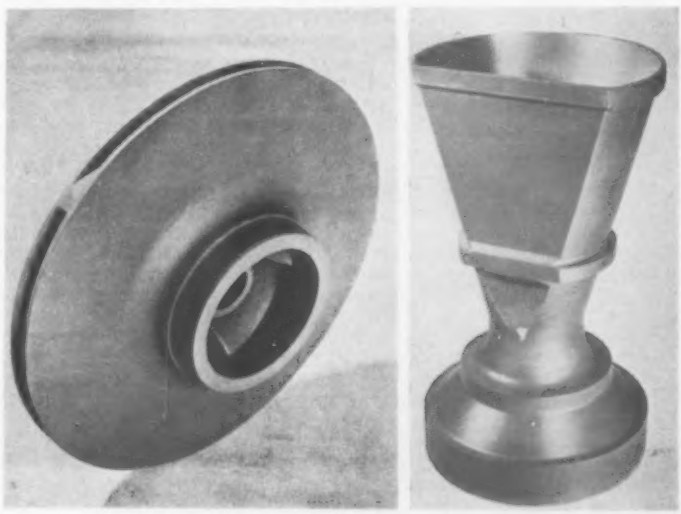


FIG. 2.—*Two industrial component castings produced from Shaw Process moulds; (left) a cast-iron pump impeller of the closed type, and (right), a space-vehicle rocket nozzle made in a heat-resisting alloy.*

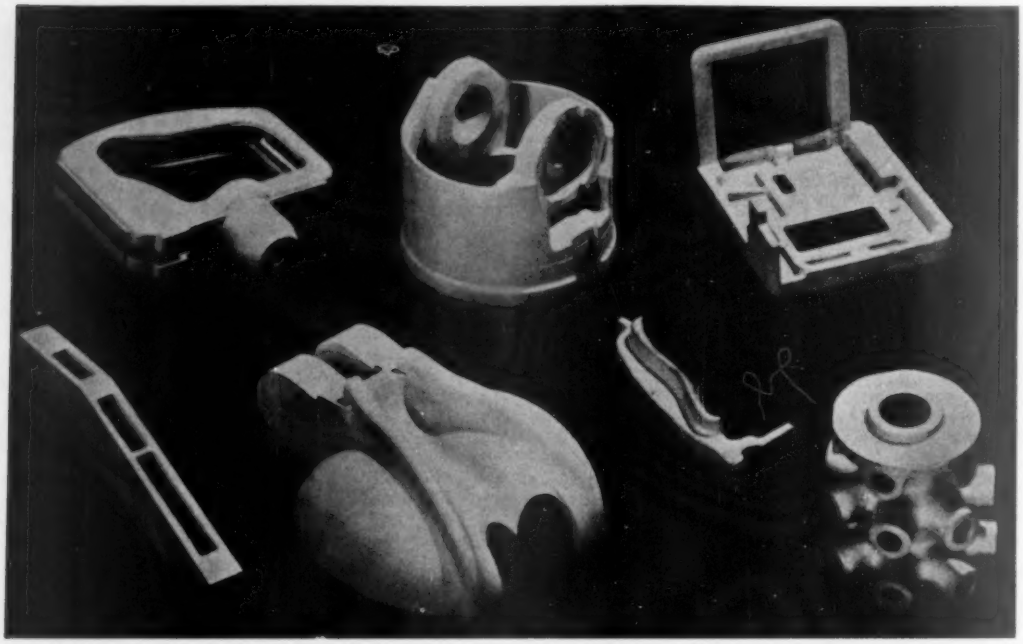


FIG. 3.—*Selection of aluminium alloy and bronze castings including an aluminium piston-head, a complex bronze valve-body, and other varied items—all produced by the Shaw Process.*

tage, these also have the ability to be cast in thin walls by pressure and gravity-die-casting.

Hence, until a low-cost precision casting process is available to iron, there can be no significant growth trend for the iron portion of the foundry industry because the existing largest need from the entire foundry industry is for products of this type. Thus, the production foundries in grey iron, malleable iron, and steel can protect their present position with a low-cost process for casting thin walls to close dimensions. Wall gauge substantially under 0.100 in. and dimensional tolerances measured in a few thousandths of an inch per inch, rather than in fractions of an inch, are the scale needed.

Shaw Process

This process is a method of making smooth, precision moulds out of ceramic-based moulding materials. It could hold the promise of making possible light, low-cost precision parts in iron, in steel, and in all castable metals. The process depends upon a pattern of micro-cracks that are developed throughout the mould in a manner similar to the cracking of a dried mud puddle in the sun. Thermal expansions and contractions are absorbed within this network of micro-cracks. The behaviour of the molten metal in the mould is unaffected by this crack system. Air and gases in the molten metal are also vented through the micro-cracks; thus the cracks function in several capacities at the same time. In its most fundamental aspect, the Shaw Process involves techniques that are closely similar to those currently used by the foundry industry. The ceramic, slurry-type moulding material is introduced into the mould shape over a pattern and is permitted to harden sufficiently to be stripped from the pattern. A subsequent torching operation forms the micro-cracks. Burning off the volatile components in the mould introduces chemical and dimensional stability. Because the moulds thus produced are fine-grained, inert, and dimensionally stable, the Shaw Process is suitable for extremely-close tolerances and fine finishes equal to those of any process known, including pressure-die-casting. These features of the process have been fairly well known and have been exploited by the special-purpose foundry industry during the past six years. Over 100 licensees throughout the world have been using this process to make castings ranging in weight from ounces to about 10 cwt. for such demanding applications as tools and dies, pump impellers, and space-vehicle components that require close tolerances in difficult-to-machine, heat-resistant alloys (see Figs. 1 to 3). In the past, the Shaw Process was confined to high-cost special-purpose castings where the relatively-high cost of the mould materials was insignificant in comparison with the savings in other phases of producing the piece. This is no longer true, since the cost of mould materials has been reduced substantially.

Significant improvements have been achieved lately in the economics of the process. Major cost reductions have been made possible by the following: Less moulding material per casting through the use of shells and shell facing with inexpensive backing (Fig. 4); reclamation and reuse of moulding materials; less metal per castings; lower-cost reagents (binders); mechanization, and a marked reduction in machining and finishing compared with greensand castings. The reduced cost of mould and bonding materials has put the Shaw Process on a competitive footing with ferrous-greensand castings for many applications, even before machining.

The Shaw Process Division of Avnet Electronics, Inc., is the licenser of the process in the Western Hemisphere and is developing a line of automated machinery for the low-cost mass-production of moulds. The first production model of this machine is under construction and will be in use in the UK in the latter part of 1961. Designs for more-advanced machinery are already under way.

Shaw "Fit"

Thus, the Shaw Process appears to have promise for accomplishing the previously described needs for process improvement. Dimensional tolerance control, surface smoothness, thin walls, and low costs appear available in the castings to be produced. An important fact about the process itself that might be overlooked, however, is that it gives a new opportunity for considerable deviation from conventional moulding operations. The use of a slurry rather than a granular material, the curing properties, and the physical nature of the moulds all present features that can be taken advantage of in new mould-making techniques.

Mould Production

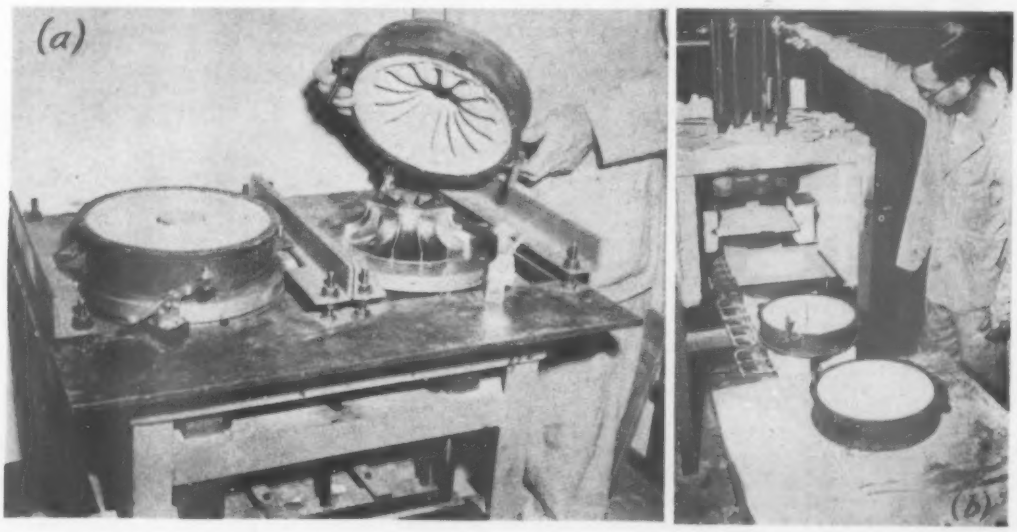
First Generation

The handling and moulding characteristics of granular-type moulding materials have determined the moulding processes used to date. The handling systems for sand mixes, the investment methods for applying them to patterns, the methods for compacting the sand-moulding mix and for obtaining the mould properties, and the techniques for handling the myriad problems of venting, hot-strength, collapsibility, etc., have all been assisted or limited by these characteristics. Great advances have been made toward mechanization of these sand processes and toward cost reduction. Indeed, in the first efforts with any new one-use moulding process, the first goal is to attempt to match these developments in cost and results. When regarded from the aspect of the improvements possible with new types of moulding materials, it may be said that present-day moulding techniques are a "first generation."

Second Generation

A mechanized moulding system is being developed for the Shaw Process. The first version of it is known as "Mark I." It uses the traditional concepts available from today's "first generation" sand-moulding techniques. These are modified

FIG. 4.—*Economics of production have limited the application of the Shaw Process to iron castings. Among the new factors that are making this method of production now practicable is the combination of a shell of Shaw material with a cheaper backing; (a) backing material is seen in place for an impeller mould, and, (b) cope and drag mould parts showing Shaw facing material in position.*



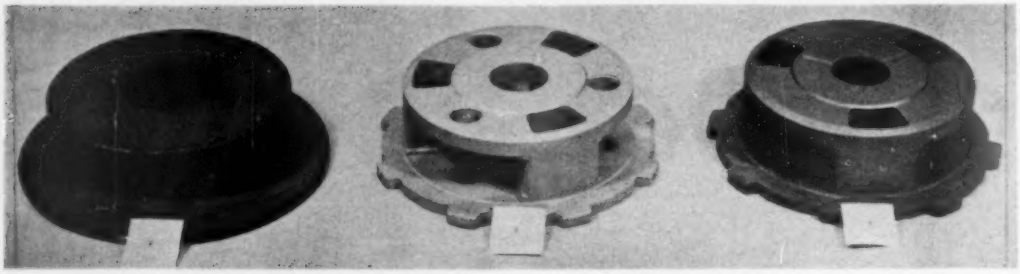


FIG. 5.—*Castings to which the relative costs in Table 2 refer; (left) malleable iron, greensand cast, 5lb.; (centre) aluminium die-cast, 1¼lb.; (right) malleable iron, Shaw Process, 3lb.*

and the slurry is adapted so that a practical competitive result is obtained without loss of the inherent features of the Shaw Process. The first production system will be available late in 1961.

Third Generation

It is important that the potentials for any new process should not be impeded by attempts to match wholly-new materials and processes with compromise or traditional techniques for their use. In this respect, the Shaw Process offers the potentialities for a new series of concepts to be introduced. These could differ widely from the present traditional methods. For example, entirely new pattern and box techniques are possible. Radical changes in the method for preparing, transferring, and investing the slurry moulding material around patterns are possible. A "Mark II" model is in the early phases of development and should be in a prototype form by late 1962.

Economics

The economics of the Shaw Process are best demonstrated by comparisons with the low-cost greensand malleable iron and aluminium pressure die-castings. These comparisons reflect the effect of design changes and casting methods, matched with optimum metal selection. Table 2 and its footnotes are self-explanatory. Fig. 5 shows the castings for which these costing exercises were made. They represent an actual motor-car industry case in which economics dictated the move from a greensand malleable-iron casting to an aluminium die-casting. The Shaw Process is compared with both of these methods. Note that the cost comparison (detailed in Table 2) is made prior to machining operations, which, as already noted, are of dominating importance in many foundry products. This application is representative of many of the castings used in motor-car applications.

Conclusions

(1) The foundry's importance to American economy depends on the technological advances it makes to meet the more demanding economic and performance requirements of our times.

(2) The industry is having difficulty in being competitive with other new processes. Competition within the industry has become more intensive. This has preoccupied the industry, detracting from profits and the talents for improving processes to develop new business. The industry has a

TABLE 2.—*Cost Comparison for Reverse-pinion Carrier of High-production Automotive Malleable Iron Transmission*

The casting was originally greensand cast malleable iron, for which machining cost was approximately $1·00* per casting. The casting was redesigned as an aluminium die casting to reduce the machining cost to approximately $0·50.

	Malleable Iron, Greensand Cast. (5 lb.)	Aluminium, Pressure-die-cast. (1¼ lb.)	Malleable Iron, Shaw Process. (3 lb.)
Material Cost:			
Moulding material ..	$0.0705*a*	$0.0695	$0.0816*e*
Metal	0.1875*d*	0.310*e*	0.1125*f*
Total material Cost ..	0.2580	0.370	0.1941
Conversion cost:			
Direct-labour plus overhead			
Moulding } ..			
Pouring } ..	0.135*g*	0.080*h*	0.135*i*
Shakeout ..			
Total Core Cost	0.011*j*	—	0.026
Cleanup, Trim, Heat-treat, Scrap	0.101*j*	0.058*j*	0.063*k*
Total Manufacturing Cost:	$0.505	$0.508	$0.4181
Sales, Admin., Profit ..	0.035*l*	0.076*m*	0.0627*m*
Selling Price	$0.540*n*	$0.584*n*	$0.4808

* A dollar is worth approximately 7s. 0d.

NOTES.—(*a*) Two-on pattern. 9 by 12 by 8 box. 50 lb. sand per mould. Sand prepared and at moulding station at $0.0027 lb. Pattern cost $600. Pattern amortization over 200,000 castings $0.003 per casting. 1 lb. of castings per 5 lb. of mould; (*b*) $9,000 for 2-cavity die plus $3,000 for die maintenance over 200,000-piece die life; (*c*) two-on pattern. New composite moulding and reclaiming techniques give $0.0073 per lb. of moulding material. 21 lb. of moulding material per mould. Moulding material formerly was $0.0976 per lb. as block mould, or $0.0193 per lb. as composite without reclaiming. Pattern amortization $0.005 per casting. 1 lb. of castings per 3.5 lb. of mould; (*d*) metal cost is based on cost per pound of metal sold, or $0.09375 per lb.; (*e*) metal cost is based on $0.235 per lb. plus 5 per cent. melt loss; (*f*) new design is based on aluminium die-cast design with some walls reduced. Casting is therefore lighter than greensand design. Presumed yield is same as for greensand, but it actually is higher; (*g*) based on $12 per ton for direct labour for sand preparation, moulding, pour-off and shakeout plus 350 per cent. overhead; (*h*) based on a production rate of 100 per hr.; 350 per cent. overhead; (*i*) mechanization of Shaw technique offsets double moulding (composite pre-form plus facing shell); (*j*) core cost includes material cost. Costs of clean up etc., were derived by difference between known end-product price and known other costs; (*k*) clean up and yield are same per piece as die casting plus $0.005 per piece for heat-treatment; (*l*) sales and administration costs are 7 per cent. profit negligible at this price; (*m*) with full profit 8 per cent.; (*n*) actual.

great potential for growth, however, because of the possibility of producing finished or very-nearly finished products from the cheapest forms of material in one step. (3) To regain a position of prominence in the metalworking industry, castings must exhibit the properties of the competitive pressure- and gravity die-casting, such as light weight, less material, thin walls, smooth finish, and close tolerances. This, together with the use of cheaper materials such as iron, would advance the foundry industry to new and unparalleled importance in the metalworking industry. (4) The Shaw Process could have the foregoing qualities as a result of recent process improvements. Over 100 licensees around the world are producing castings with this process. Machines are now under development to mechanize Shaw mould making for the very-high-production items, and the first production system will be available late in 1961. If this process should not fit the needs for renewed foundry growth, certainly the features it offers must be made available by another process.

American Letter

ASM Meeting Report

The National Metal Congress, held in Detroit from October 21 to 27, was sponsored by the American Society for Metals and supported by nine additional technical societies, representing metallurgical groups and including welding, testing, heating and powder-metal industries. Included in the programme were no fewer than 265 technical papers and out of this number, approximately three dealt with foundry subjects. These were "Quantitative Metallographic Analysis of Graphite Size in Ductile Cast Iron," by J. H. Brophy; "Additive Effects of Alloying Elements on the Mechanical Properties of Cast Austenitic Alloys at 815 deg. C.," by D. L. Sponseller, R. A. Flinn and R. W. Kraft, and "Use of Radioactive Tracers to Study Piston-ring Wear in Locomotive Diesel-engines," by A. S. Pedrick. The Metal Congress was supplemented by an exhibition of metallurgical products and was well attended throughout the whole of its programme.

Mr. REGINALD G. TOLLEY has been elected to the board of Simms Motor Units, Limited.

Shaw Process Conference

Group photographed at the recent Shaw Process conference in London and Leighton Buzzard. From left to right are Mr. Clifford Shaw, Mr. Noel Shaw, Mr. Lester Avnet, Mr. Austin S. Beech (Foundry Equipment, Limited), Dr. George Found (Author of this paper) and Mr. Irwin Lubalin, also from America.

General group of Shaw Process licensees and members of the firms of Shaw Processes, Limited, and Foundry Equipment, Limited, photographed outside the Leighton Buzzard works of the latter firm during the proceedings of the Shaw conference recently. Included in the front row are Mr. H. Hertzmark, Mr. H. J. Thompson, Mr. Clifford and Mr. Norman Shaw, Mr. L. Avnet, Mr. Austin S. Beech and Mr. Noel Shaw.

Production of Iron Castings

Easing of Activity in Third Quarter

After a period of steady trade up to mid-1961, the ironfounding industry suffered a reduction in its rate of output in the third quarter of this year over and above the normal seasonal fall, states the Joint Iron Council following publication of the Iron and Steel Board's production figures. Total output of iron castings in the third quarter was 846,000 tons which compares with 904,000 tons in the corresponding 1960 quarter—a reduction of 6½ per cent.

Commenting on the various sections of the industry, the JIC says there was a noticeable fall in the rate of output for the automobile section, which had previously shown signs of improvement; the reduction was confined mainly to cars, and the section as a whole continues to be aided by a firm demand for tractors and commercial vehicles. The engineering section steadied after edging forward in the first and second quarters, but the building section maintained an output above that of the corresponding quarter last year. A sharp decline in production of ingot moulds was a direct result of the setback in the steel industry. Output of pressure-pipes continues at a rate appreciably lower than a year ago, and little change is shown in the production of castings for railway equipment. (Analyses of district and sectional production are given in Tables 1 and 2.)

TABLE 1.—*Production of Iron Castings, by District.*

District.	Iron Castings (tons).	
	Third quarter 1960.	Third quarter 1961.
Eastern, South-Eastern (incl. London), Southern and South-Western	102,250	98,070
Midland	203,400	190,420
North Midland	185,730	163,240
East and West Ridings	82,780	87,250
North Western	85,040	83,670
Northern	103,150	91,680
Scotland and Northern Ireland	82,790	79,160
Wales	58,570	52,410
Total	903,710	845,900

TABLE 2.—*Output of Iron Castings, by Section (Thousand Tons).*

Section.	Third Quarter.		Percentage change.
	1960.	1961.	
Automobile (including tractors)	178.3	157.3	—11.8
Engineering (*a*)	296.3	296.4	0.0
Building and domestic (*b*)	121.9	125.7	+ 3.1
Pressure-pipes (*c*) and fittings	122.4	106.6	—12.9
Ingot-moulds (*d*)	124.4	100.4	—19.3
Railway equipment	60.4	59.5	— 1.5
Total	903.7	845.9	— 6.4

(*a*) Including machine-tool, textile machinery, electrical, shipbuilding, etc., (*b*) About ⅓ of the total consists of castings for domestic goods, *e.g.* stoves, cookers, refrigerators, etc., (*c*) Mainly gas and water, (*d*) Mainly for the steel industry.

AN ENGINEERING FIRM in the Netherlands, Machinefabriek Voorwaarts N.V., of Amsterdam, a subsidiary of N.V. Bronswerk of Amersfoort, has recently completed what is claimed to be the world's largest shakeout unit. The unit, which will be installed in the Krupp Works in the German Federal Republic, is said to be capable of dealing with castings up to 70 tons. The Dutch firm is working under an arrangement with the US Hewitt-Robins concern.

International Journal of Production Research

The Institution of Production Engineers held a Press reception at 10, Chesterfield Street, Mayfair, London, W.1, at the end of last month to launch their new quarterly magazine under the above title. Following a brief introduction by the Institution's president, Mr. Harold Burke, Professor N. A. Dudley (of the University of Birmingham), who is honorary editor of the new journal, explained its purposes and objectives. These he described principally as providing a forum at which high-level research workers and production engineers could make known their results (in English, French and German) and use them as a basis for collaboration amongst each other and with industry. The new publication, it is reported, will embrace aspects of production—production policy, planning and control; industrial skills; productivity measurement and production processes in various technologies. Mr. Burke said that initially a circulation of about 1,000 was aimed at and at this number, the publication price of £4 4s. to IPE members and £5 5s. to non-members, the journal should be self-supporting in cost. The first issue contains 65 pages, size 10 in. by 7 in., and includes nine papers.

Work-study Courses at Loughborough

In a four-page folder, the Loughborough College of Technology, Loughborough, Leicestershire, gives details of its courses in "Work-study and Allied Management Studies" for the spring and summer terms of 1962. The courses cover: basic work-study; work-study for office and sales functions; production planning and control, and office organization and methods and digital computers. The folder, which also contains information about accommodation, fees, etc., is obtainable from the head of the department of industrial engineering and management studies at the address quoted.

Practical Help: The photograph below shows a group of Tristan da Cuhnans at work loading dried foundry sand at the Redhill quarries of British Industrial Sand, Limited, the first local industry to offer employment to the refugees. Six are now working at Redhill and seem to be settling down well to unaccustomed tasks.

Equipment and Supplies

X-ray Units

The industrial division of Watson & Sons (Electro-Medical), Limited, East Lane, North Wembley, Middlesex, have introduced three additions to their range of Andrex portable X-ray units, offering the advantage of reduced weight and, in the case of two of the units, increased tube current ratings. The 250 kv., 6mA unit has a tubehead weighing 156 lb. only (over 100 lb. less than the previous model), the beam angle is 60 deg., enabling two 15-in. films to be taken at a focus/film distance of less than 30 in. The 250 kv., 360 deg., 5mA unit has a tubehead weighing 153 lb. and is stated to be suitable for the examination of steel in thicknesses up to 2 in. The 360 deg. band has an effective width of 40 deg., and a "forward throw" and a lead belt with radiation port is provided, enabling the unit to be used for directional work.

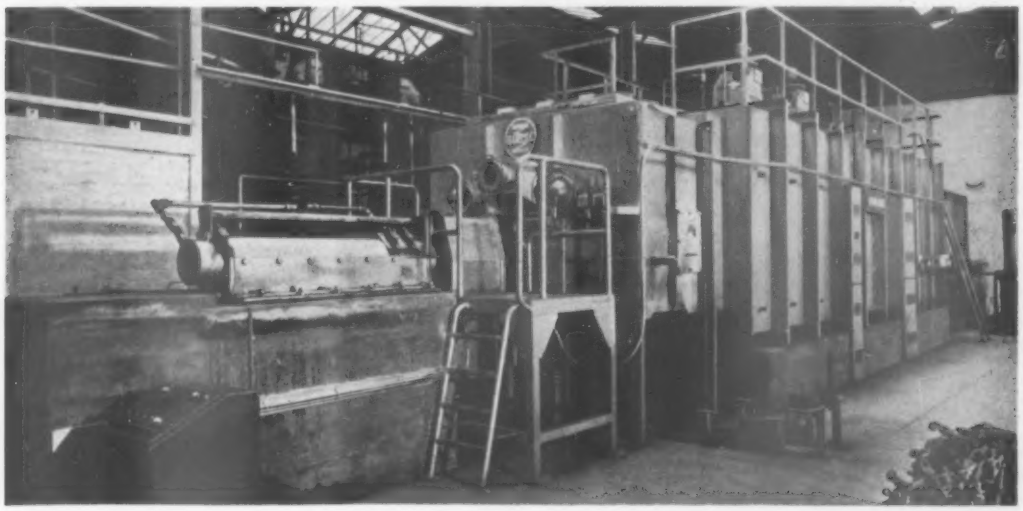
Hardness Testers

George H. Alexander Machinery, Limited, 82/84, Coleshill Street, Birmingham, 4, have been appointed sole selling agents in the UK for the range of "Emcotest" portable hardness-testers manufactured by Maier & Company, Halleim, Austria. These instruments have been developed recently and—it is claimed—permit of constant, reliable and accurate readings in Rockwell, Vickers or Brinell hardness scales, to be carried out on the spot and in any position. Instead of weights, the test loads are applied by means of springs which, in order to ensure the necessary constancy, are subjected to a special finishing process. All components, such as the test load, penetrator and depth gauge, are enclosed in a single testing unit. A wide range of hardness testers are available, under the trade marks "Emcotest" and "Emco-Intest," and include instruments equipped with a special anvil for the testing of crankshafts, hardness testers for large cylinders, machine-tool beds, gear teeth, etc. The makers claim that their internal hardness testers can carry out tests at any position in the bore of holes, from a minimum inside diameter of 1.2 in., and that the whole range of instruments available are not effected by any vibration or shock, are suitable for testing in any position, and do not require any specially-prepared base.

Bentonites

Chemicals & Feeds, Limited, Adelaide House, King William Street, London, E.C.4, have been appointed sole agents for the UK and various other countries for the Italian 7C range of bentonites produced by Ditta Dott. Settimio Cinicola, Milan, of which a special grade is produced for the foundry industry. In addition, Chemicals & Feeds announce that they are now sole UK and European agents for ground manganese carbonate (Rhodochrosite ore) from Taylor-Knapp Company, Montana, and that quantities of material are available, ground to convenient mesh-size, and incorporating a high Mn content with low impurities.

Malleablizing Furnace (Continuous): The illustration (below) shows a Birlec continuous furnace for annealing whiteheart malleable iron. This is the first unit of its size to be built in the UK. Of 100 tons per month nominal output, it has been put into service at Bullers, Limited, Tipton, and has now been operating for several months. (Other furnaces for installation abroad, for outputs 50 and 100 per cent. greater than this, are under construction.) The unit at Bullers is electrically heated, but furnaces of this type can be gas-fired if required. It is a pusher furnace, with the castings loaded in trays which comprise cast nickel/chromium grids surmounted by specially-designed containers, the grids in turn being supported on cast nickel/chromium shoes which rest on the rails running throughout the furnace track. The furnace illustrated is rated at 250 kw. and the heating elements (located on the sidewalls of the chamber) are divided for correct control into three zones. At present, a 76-hr. cycle is being used, one tray being discharged every four hr., and each tray having a normal capacity—with suitable castings—of approximately 11 cwt., its volume being about 13 cu. ft. The furnace manufacturers are AEI-Birlec, Limited, Erdington, Birmingham, 24.



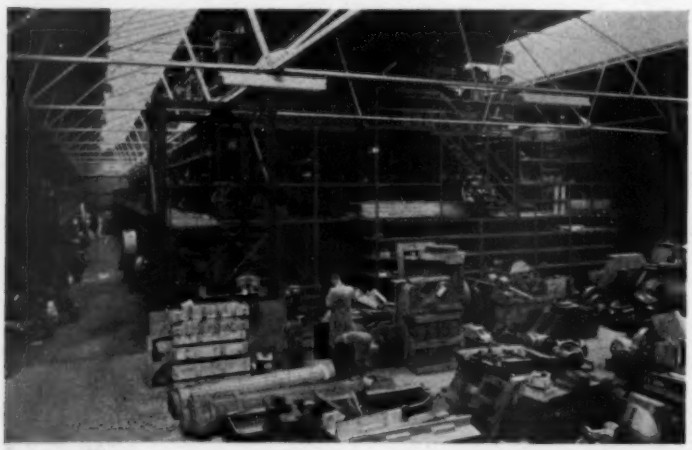
Loading Shovel: Above is illustrated a hydraulic loading shovel tipping slag into a waiting road-tipper in the Dagenham foundry of the Ford Motor Company, Limited. The shovel has a 1 cu. yd. capacity, an overall length (bucket lowered) of 16 ft. 2 in. and an overall width of 6 ft. 6 in. At Dagenham, three of these machines (made by F. E. Weatherill, Limited, Tewin Road, Welwyn Garden City, Herts) are now in service in the foundries—a particular service being the loading of the cupola "drop"—whilst a fourth (a "Hi-tip" model) is in use for coke-loading. Three loader units of ¾-cu. yd. capacity are in service at Ford's foundry at Leamington for similar duties, it is reported.

Shotblasting and Painting Service: A new company for "start to finish" site work in shotblasting and painting was launched at a Press reception in London last month. In the new company, Site Shotblasting & Painting Company, Limited, of Commercial Street, Birmingham—five firms (a site shotblasting company, three painting contractors and a paint manufacturer) have combined to provide a mobile plant and buildings maintenance service available anywhere in Great Britain, it is announced. The chairman is Mr. G. E. Lunt and teams of skilled men from a total labour force of 2,000 will operate from seven centres. (Mobile units will also work overseas by special arrangement). The constituent companies are: the site shotblasting division of R. J. Richardson & Sons, Limited; Abbott of Harrow, Limited; Arnold Sharrocks, Limited, W. C. Simpson & Son, Limited, and John S. Craig & Company, Limited. (Mr. Lunt is deputy chairman of R. J. Richardson & Sons, Limited, a member of the Staveley group of companies.)

Aluminium Billet Cutting: A number of scrap aluminium billets, each 24-ft. long, 3-ft. dia. and weighing about 12 tons, were recently cut to furnace size by thermic boring at International Alloys, Limited, Aylesbury. With this process the job was carried out far more quickly and economically than by mechanical methods such as sawing, it is claimed. Because of the size and weight of the billets, mechanical cutting would have meant installing expensive equipment and greatly increased material handling costs. Each billet was cut into three sections, and each cut took about 22 minutes. Thermic boring, developed in the UK by the British Oxygen Company, Limited, is a process closely allied to oxygen-lance cutting.

Sealed Water-quench Furnace: G.E.C. (Engineering), Limited, has recently received an order, valued at over £10,000, for a sealed water-quench furnace. It is for installation in the Burnley Works of the Lucas Gas Turbine Equipment, Limited, and it will be used for the annealing and hardening of various types of high-grade steel and steel alloys employed in the aircraft industry. The rigorous requirements of this industry call for an accurate control of the furnace temperature so that the treated parts may have uniform characteristics.

High-purity Metals: In the latest series of data sheets issued by Johnson, Matthey & Company, Limited, 73-83, Hatton Garden, London, E.C.1, information is given on 38 metals including noble, rare-earth, and certain base and rarer metals. The general properties of each element are tabulated and details are given of the forms of current production. In most cases the metals are available in more than one grade, the metallic impurity contents being expressed in parts per million. The data sheets are available to readers free on request to the address quoted.



Racking: The illustration on the left shows a view of the pattern stores at the Bathgate foundry of North British Steel Foundry, Limited, in which the racking has recently been extended from a two- to a three-tier structure using Dexion slotted angle. The main units are 150-ft. long.

Solvent: Imperial Chemical Industries, Limited, has completed a plant at Widnes, Lancs, to make 1.1.1-trichloroethane—a solvent not previously manufactured in the UK. The new solvent, known as "Genklene," is stated to be non-inflammable, of medium volatility and low toxicity and therefore suitable for cold cleaning. It can be applied by wiping, dipping or spraying and it is claimed that it can be purified by distillation for re-use if required. The solvent is available in 5- and 45-gal. drums.

"Growing Forms"

North Road Foundry (Ferrybridge), Limited, Grange Works, Ferrybridge, Yorks, have recently cast a relief sculpture for Bodington Hall of Residence,* of Leeds University. The sculptor of the relief (shown opposite), which depicts "growing forms," was Mr. Hubert Dalwood; it was made in modified aluminium alloy, LM 6 to BS 1400. The relief was made in 36 sections, the average size of each being 4-ft. 6-in. by 4-ft. The total finished weight of the sculpture, which has an overall size of 26 by 22 ft., and an average thickness of ¾ in., is 2 tons 3 cwt. the metal being supplied by Alcan—Enfield Alloys, Limited, Bradford Works. The work was anodized a natural grey metallic colour before erection.

Method of Manufacture

The relief was first made in plaster and cut into the 36 sections, after the joint-lines had been agreed with the foundry. From each section, a plaster pattern was made, each reinforced with glass-fibre sheet and irons.

Relief sculpture in aluminium alloy recently cast by North Road Foundry (Ferrybridge), Limited, Yorks. It is 26 by 22 ft. overall size and the finished weight is 2 tons 3 cwt.

[Courtesy: Photo Press, Leeds

Four bosses on each section were built up to form common register-points and these were used for fixing the finished panels to the wall at Bodington Hall. The castings were moulded in greensand with a well-milled and bonded facing sand, a considerable number of gaggers being required, because of the difficult "draw" and the depth of joint. The main difficulties in manufacture arose as a result of the uneven surface of the patterns and their inconsistent thickness. Thus where the thickness was suspected to be insufficient, the top part of the mould was skimmed off. Each of the 36 sections of the relief was cast with three pots of metal, with about 12 ingates to each mould, the casting temperature being 720 deg. C.

North Road Foundry has cast a number of "objects" for Mr. Dalwood, both in aluminium and gunmetal, one such casting (in gunmetal), weighing 12 cwt. and about 4-ft. high, was recently installed in the forecourt of the premises of E. J. Arnold & Son, Limited, Leeds.

* The architect for the Bodington Hall of Residence was Denis Jones, of Jones & Stocks, Limited.

PRIESTMAN BROS., LIMITED, makers of earth-moving machinery, Hull, have received an order from the Polish Government for 125 Cub excavators. The order, which will bring to almost 400 the number of Hull-built excavators working in Poland, was secured in the face of strong Continental competition and also increasing opposition from Poland's own rapidly-developing engineering firms.

Hungarian Foundries Plan

Foundry modernization programme costing 1,000,000,000 forint (£30,000,000) to increase production of grey-iron castings by 60 per cent., steel castings by 35 per cent., light non-ferrous castings by 40 per cent., and malleable cast iron by 80 per cent., has been approved by the Hungarian Parliament as part of the country's five-year (1961-1965) plan. Most important investments will go to foundries at Soroksár, south of Budapest, at Sopron, in the west, and at Kecskemét, in central Hungary. The Kecskemét foundry will be the first in the country to be fully automated.

Output at the Soroksár iron foundry is expected to rise from the present 10,000 tons annually to 30,000 tons, by the introduction of automation, while mechanization of the Sopron plant should raise production there to 10 times the present level. The Sopron foundry is expected to become the principal supplier of malleable cast iron to Hungarian industry. Other foundries, including those of the Láng machine factory, the Gheorghiu-Dej shipyard, the Csepel steelworks, and the Ganz-Mávag wagon works, all in Budapest, are to get additional machinery under the plan.

New cold rolling mills, built at Salgótarján, in northern Hungary, at a cost of 250,000,000 forint (about £7,500,000), has been completed six months ahead of schedule. Originally planned to begin production in May, 1962, the new installation came into operation on October 28.

Personal

Mr. E. F. HODGES, A.I.M., has resigned from the posi- of technical director with Knowsley Cast Metal Company, Limited, to return to private consultancy practice.

MR. V. A. G. LAMBERT, deputy chairman of the Projectile & Engineering Company, Limited, has been appointed chairman in place of the late Mr. J. WADDELL.

MR. E. R. HENSCHKER, and Mr. R. M. L. ELKAN have been appointed directors of the Loewy Engineering Company, Limited, of Bournemouth, a member of the engineering division of Tube Investments, Limited.

Mr. ANGUS MURRAY, managing director of the Expert Tool group, London, W.1, has been appointed chairman of the recently-acquired subsidiary, S. E. Opperman, Limited, general engineers, Boreham Wood, Herts.

Mr. W. T. MITCHELL, son of the late Mr. W. T. MITCHELL, has been appointed chairman of the Grahamston Iron Company, Limited, Falkirk. Mr. H. C. STEWART and Mr. R. GARDNER become joint managing directors.

Mr. R. E. BERRY has been appointed chief metallurgist and director of the wrought metals division of Manganese Bronze & Brass Company, Limited, Ipswich. The appointment was made retrospective to the beginning of the year.

Mr. D. D. MCTYRE, erection manager of Aiton & Company, Limited, pipework engineers, of Derby, has returned from a business world tour by air, during which he visited Canada, New Zealand, Australia, Singapore, Cairo and Khartoum.

Electric & Musical Industries, Limited, has appointed the following as divisional directors of the company: Mr. P. A. ALLAWAY, Mr. E. G. HURST, Mr. W. ROXBURGH, Mr. J. G. STANFORD, Mr. N. E. TOMLINSON and Mr. L. G. WOOD.

MR. LEONARD DARLING has retired as a director of the Broken Hill Proprietary Company, Limited, and its subsidiaries, Australian Iron & Steel Pty., Limited, B.H.P. By-products Pty., Limited, and Tasmanian Electro Metallurgical Company Pty., Limited.

MR. RONALD FITCH has been appointed chief accountant at the Trafford Park works of Lancashire Dynamo & Crypto, Limited, a company in the Metal Industries group. Mr. Fitch was formerly chief accountant with A. V. Roe & Company, Limited.

MR. ALBERT MITCHELL has been appointed head of the department of mechanical, production and civil engineering at the Rotherham College of Technology, to succeed his present chief, Mr. J. O'NEILL, who has been appointed vice-principal of the Derby College of Technology.

MR. A. KENNEDY AITKEN is to retire as a director of R. & J. Dick, Limited, of Glasgow, at the annual meeting on December 22. He joined the company in 1919 and was appointed a director in 1925. In 1936 he became managing director from which post he retired in 1955.

MR. E. T. JUDGE, chairman and managing director of Dorman Long & Company, Limited, has been appointed chairman of its subsidiary, Darlington & Simpson Rolling Mills, Limited. Mr. JAMES JACK, previously financial director of Dorman Long, has been appointed managing director, group finance and administration. Mr. THOMAS YOUNG has been appointed secretary of the company.

MR. T. O. HUNT, managing director of Specialloid, Limited, has been elected chairman of the company and of its subsidiaries. He will continue as managing director. Mr. D. I. BALL has resigned as chairman and from the board of the company and its subsidiaries. Mr. S. W. LEWIS has been elected to the board of Specialloid, a nominee of Clifford Motor Components, Limited. These changes are in accordance with the terms of the offer by Clifford Motor Components to acquire the ordinary capital of Specialloid.

SIR WILLIAM GARRETT has retired after 26 years as a director of Monsanto Chemicals, Limited, and Mr. J. M. KERSHAW has been appointed to the board. Sir William joined the company in 1917 and was appointed a director in 1935. He is retiring from the board at his own request in order to devote more time to his other interests. Mr. Kershaw who is Monsanto's director of production, joined the company in 1946, as a chemical engineer. He was appointed chief engineer in 1956 and director of production in 1960.

Professor R. W. K. HONEYCOMBE, Professor of Physical Metallurgy at Sheffield University, has been given leave of absence to go overseas. He will be away for seven months next year, when he becomes visiting professor in physical metallurgy at the University of Melbourne, Australia. Dr. J. CRANGLE, senior lecturer in physics at Sheffield University, has been given similar leave of absence in order to present a review paper at the annual conference in New York of the Metallurgical Society of the Institute of Mining and Metallurgical Engineers.

Obituary

The death took place of Mr. JAMES S. HENDERSON, managing director, Geo. Henderson, Limited, of Kelso Foundry, Kelso, on November 22.

Mr. GEORGE IRVIN OGLEY, retired works accountant of Newton Chambers & Company, Limited, Chapeltown, Sheffield, has died at Rotherham at the age of 74.

The death has occurred of Mr. FRANK SMITH, head of the department of science and general studies at the Longlands College of Further Education, Middlesbrough, and previously lecturer in mathematics at the Constantine Technical College.

The death has occurred at the age of 50 of MR. KENNETH LLOYD OLIVER, general manager of the David Brown Machine Tool and Tool Divisions, and a director of David Brown Industries, Limited. In 1937 he joined Muir Machine Tools, Limited (now the David Brown Machine Tool Division) as assistant chief draughtsman, and became factory manager in 1944. In 1956 he was appointed general manager of the two divisions, and joined the board of David Brown Industries, Limited, in 1959.

The death is reported on November 23 at the age of 73 of SIR GREVILLE S. MAGINESS, K.B.E., deputy chairman of the Churchill Machine Tool Company, Limited, Altrincham, and of Associated British Toolmakers, Limited. Knighted in 1947, he was created a K.B.E. in 1947. Since 1938 Sir Greville had been president of the Russo-British Chamber of Commerce, and during the war was president of the Machine Tool Trades Association. From 1944 to 1946 he was president of the Engineering and Allied Employers' National Federation and from 1946 to 1950 of the British Employers' Federation.

SECTION DEVOTED TO THE TECHNOLOGY OF PRODUCING DIMENSIONALLY-ACCURATE CASTINGS

Polystyrene, a Material for Patterns*

By C. H. Waxman, B.Sc., A.P.I.

The expendable pattern forms a most important part of the investment-casting process, for the fine detail, finish and accuracy required in the casting can only be obtained if it is reproduced from the pattern. The aim of this paper is to survey the basic principles of injection moulding of polystyrene, the range of mouldings which can be obtained, and the properties of the material which are of interest to the investment caster. Extracts from the discussion which followed presentation of the paper are added.

The material chosen for making investment patterns should have the following properties:— (1) It must fill the die completely, (2) have a good surface finish, (3) thermal expansion should be as low as possible, (4) its removal must not affect the ceramic, and (5) it should be stable to atmospheric changes.

The original and still most-widely used material is wax, nowadays mostly of the micro-crystalline type. Although the wax used for patterns has received considerable attention and is often hardened with natural or synthetic resins, it still has certain defects, such as high shrinkage, brittleness and lack of stability. It was therefore natural that the investment casting industry should look for a material without these defects. Amongst the likely materials are the thermoplastics (*i.e.*, plastics that can be re-softened by heat), and of these probably polystyrene is the most interesting because of its low cost and excellent properties. Polystyrene offers the investment caster some useful advantages over other pattern materials. It is tough, dimensionally stable, and it has a hard surface which reproduces the tool finish extremely well. It can be produced at high rates of output, and parts made of it are easily stuck together. These advantages, together with its low cost, offset the lack of recovery of the material on removal of the pattern, and, the higher tool cost. It is anticipated, therefore, that polystyrene patterns will also offer economic advantages, particularly for long runs and for larger quantities off the tool.

Injection-moulding Principles

Because of its low viscosity, wax is moulded under very-low pressures. Polystyrene is rather different in its characteristics. It requires a higher temperature to soften it, and as it has a much-higher melt viscosity, it requires much higher pressures than wax to mould it successfully (see Table 1). Consequently, machines for moulding polystyrene are very different from those used for wax. Fig. 1 shows a typical machine for the injection moulding of polystyrene. A common operating sequence would be as follows:—

Pellets or granules are loaded into the hopper at the top of the machine. As the ram comes forward on its injection stroke, the feed mechanism meters the required amount of material into the injection cylinder. When the ram returns, the granules fall down in front of it, and on the next stroke are pushed forward into the heated zones. As the material moves forward it gradually softens, and passes round the "spreader" which is designed to force the material into thin streams thereby getting the best possible heat transfer. By the time the material reaches the nozzle (which takes 10 to 20 shots) it is fully plasticised at a temperature of about 200 deg. C. At this point, the polystyrene is still very viscous. Consequently the pressure required at the nozzle to inject the plastic into the mould can be as high as 8,000 lb. per sq. in. As a result of this, the locking pressure required is also high. The actual injection cycle is very similar to that for wax, consisting of injection, packing until the gate freezes, and cooling. Most machines are now either fully automatic or semi-automatic (requiring the operator only to remove the moulding and start the fresh cycle) and high-output rates can be achieved. For example, a small moulding weighing about 15 gm. can be moulded on a 10 to 15 sec. cycle (and even higher rates are achieved on specially-adapted machines producing a single article, *e.g.*, bottle caps or containers).

However, the actual rate depends on the complexity of the job and the accuracy required, as well as on the size of the moulding compared to the rating of the machine. It also depends on the number of cavities. This is particularly true of long runs of one design, which tend to be more economical if made in multi-cavity moulds.

Moulds for Polystrene

Generally speaking, most plastics mouldings are required in large quantities, and with a very-high finish. The moulds have also to stand up to the

* Paper presented to the third annual conference of the British Investment Casters' Technical Association. The Author is on the staff of Monsanto Chemicals Limited, Fulmer, Slough, Bucks.

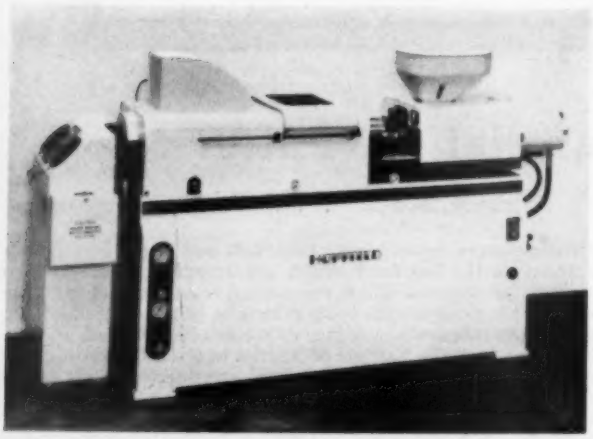


FIG. 1.—*Typical injection-moulding machine for polystyrene. Relative to wax this material has a much-higher melt viscosity, and the greater moulding pressures involved are reflected in the different character of moulding machine used.*

high pressure involved. Consequently, they are usually made of tool steel and are polished or sometimes chromium plated. Moulders will not normally put down a mould of this type unless they can see a requirement for a minimum of 10,000 off the tool. At the same time, the mould would be expected to have an ultimate life of up to 1,000,000 mouldings. However, there is no reason why moulds cast in the softer alloys should not be used for short runs, provided that they are protected by a strong bolster which will take the locking pressure. It is also possible to use cast epoxide resin moulds, but unless these are filled with aluminium wool, their heat transfer coefficient is poor, and only a low output rate will be possible. For longer runs, cast steel moulds could be used.

Moulds may be of two or three plate construction, depending on the feed system adopted. Feed is through a gate *via* sprues and runners (similar to wax practice). The gate may be "open" or "pin-point" (by a "pin-point gate," we mean a gate with a diameter of $\frac{1}{8}$ in. or less). The latter is the system often adopted for smaller parts without difficult flow paths, as it saves the degating operation on the moulding. However, on thick sections it is usually necessary to use an open gate to prevent sinking. Sprues and runners are more difficult to deal with than in wax. It is not considered good practice to feed them directly back into the machine, as one would feed the wax sprues back into the melt pots. Normally one would regrind the scrap and mix it with virgin material in the proportion of 10 to 20 per cent. Some loss must result from this handling, and this is usually of the order of 10 per cent. of the weight of sprues and runners. To save the cost and space for this operation, it is possible to use a hot-runner system. In this case the runner remains fluid, and stays in the press. There is therefore no degating or re-grinding to be done. This system obviously increases tool costs, and is usually only economic on long runs. It is also used to maintain the temperature of the material in a longer runner system, *e.g.*, in a large moulding. Moulds should be cored for water circulation, and this is particularly important where high accuracy is required. It enables the moulder to control the temperature of the mould, and therefore its size. It also prevents variation in filling time or effective-dwell time, which as will be seen later, helps to control the dimensions of the moulding.

Because of the factors mentioned above, moulds for polystyrene will cost more than the corresponding mould for injection of wax. This difference will vary from one third more to about three times as much on deep cavities. It is very difficult to be specific on this, owing to the wide differences in mould making techniques and moulding requirements.

Range of Mouldings

A very-wide range of mouldings can be produced in polystyrene by taking advantage of the variety of machines available, and by making use of the appropriate grade of material. This latter point is dealt with more fully later in the paper. Features of a moulding which are of interest to the investment caster are: (*a*) size, (*b*) maximum thickness possible, (*c*) variety of shape and complexity thereof, and (*d*) accuracy (including shrinkage and sample variations).

Size

Very large and/or heavy mouldings (weighing up to 200 oz.) are now made in polystyrene, and no difficulty should be experienced by the investment caster in this respect.

Thickness

The maximum thickness that can be moulded depends on the shape and complexity of the

TABLE I.—*Melt Viscosity of Wax and Polystyrene at Moulding Temperatures.*

Wax.			Polystyrene.		
Temperature, deg. C.	Viscosity, poise.		Temperature, deg. C.	Viscosity, poise.	
	Wax A.	Wax B.		Lustrex G.P.	Lustrex Hi-Flow.
60	10	200	160	18,200	11,000
65	2.5	150	170	12,600	8,500
70	1.4	80	180	9,900	6,900
75	1.0	67	190	7,500	5,400
80	0.8	52	200	6,300	4,500
85	0.6	42	210	5,000	3,600
90	0.5	30	220	4,500	2,900

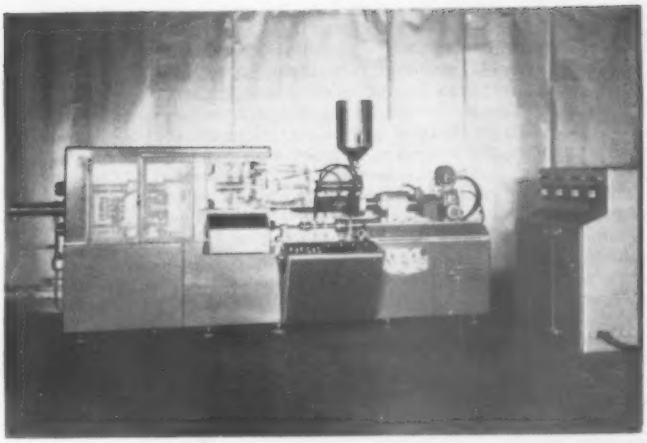


FIG. 2.—*Multi-station polystyrene-moulding machine, the use of which enables the problem of the relatively-slow cooling of thick sections to be overcome in certain instances.*

moulding, and the feed system, as with wax. The main limitation is of course sinking, as no doubt those experienced in wax moulding will appreciate. Polystyrene has the advantage that its shrinkage is much less than that of wax, and that being a glassy solid, rather than a crystalline one, the change to the solid state is more gradual. It is therefore much easier to control sinking in polystyrene than in wax, and in fact it is possible to mould polystyrene in sections up to 1½ in. thick. Most mouldings are, of course, much less than this thickness, the average value of the industry being about $\frac{1}{32}$ in., but this is owing to other factors such as cost and the applications normally dealt with. A good example of a heavy section is a ladies' shoe heel and very large numbers of these are now injection moulded. On the other hand many mouldings are made with a thickness of about 0.020 in., for example, in food packaging.

Practical limits to the thickness that can be moulded are set by two factors: (1) Length of cycle, and therefore cost of part, and (2) design of part, *e.g.*, sudden changes in section. In general, it is possible to mould thicker sections in polystyrene than wax, without sinking occurring. In some cases, the difficulty of slow cooling of thick sections can be overcome by the use of a multi-station machine (Figs. 2 and 3). This enables several moulds to be used in rotation; the use of such a machine is, however, limited to moulds with similar cavities.

Shape

Intricate shapes can be moulded in polystyrene, provided that section changes are not too sudden, and that reasonable runner and feed paths are possible. These problems are no doubt, also present in designing for wax, and it is probably not necessary to elaborate on them. Mould costs will be higher by a larger factor on complex shapes, owing to the greater precision required for operating split moulds for polystyrene than that required for wax. This is due to the higher pressure used for moulding polystyrene. More mouldings will therefore be required to make the tooling economic.

Assembly

The question of complex shapes is very much tied up with assembly problems. In this respect, polystyrene has a big advantage. Parts are easily stuck together with solvent with no risk of damage, distortion or loss of accuracy. For medium-length runs it may well be more economic to mould two fairly-simple shapes and stick them together, rather than pay for the tools required to mould the final pattern.

Accuracy

It is reasonable to expect high accuracy from polystyrene mouldings, provided the moulding is done under controlled conditions. The requirements for good results are: (1) Good control of material temperature and injection pressure, (2)

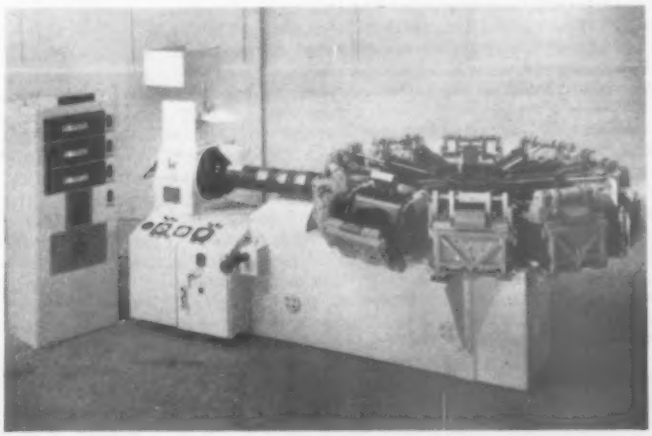


FIG. 3.—*Another type of multi-station polystyrene moulding machine (shown here without guards).*

accurate cycle control, (3) control of mould temperature, and (4) well-maintained equipment. In some work that has been carried out at Fulmer, it has been found that material temperature and injection pressure have a significant effect on the dimensions of the moulding (Figs. 4 and 5). The temperatures were measured by deep-seated thermocouples which reached to within $\frac{1}{4}$ in. of the inside surface of the cylinder. These effects were produced on a test bar at the end of a rather-long runner system. On a simpler mould with a shorter runner system, the effect of material temperature changes would be more marked. The effect of variations in cycle times will also be significant. The overall cycle is made up of: (1) Plunger forward time—injection followed by dwell; (2) cooling or cure time followed by ejection; (3) dead time. Variations in (1) may be made either by altering injection rate, thereby altering the proportion of dwell time, or by alteration of the overall time. Both will affect the packing time relative to the gate-freeze time, and therefore will alter the total weight of material in the mould. Three types of control may be met with: (1) *Manual*—all stages of the cycle are under control of the operator; (2) *semi-automatic*—only "dead-time" is controlled by the operator; (3) *automatic*—complete cycle is controlled by timers. But under all of these systems it is possible to obtain control of the cycle to within ± 1 sec. In system (1) or (2) it is only a matter of training the operator to work to a clock. Control of mould temperature is important for two reasons: (1) Variation in mould temperature will affect its size and therefore that of the moulding. This is particularly important during the first hour or two of a run, when, without mould-temperature control, the mould will tend to warm up through the repeated injection of hot material into it. (2) Variations in mould temperature will also affect the rate of cooling of the material as it is injected into the mould and this together with the size of the mould, will affect the effective-packing time, and therefore the size of the moulding. The preferred system of control is by circulating a large volume of water through the mould and through a temperature-control unit, capable of holding the water temperature to within ± 1 deg. C.

Obviously, to achieve these results, the equipment must be well maintained, so that controls work properly, and so that gauges read the true values of the variables being measured. Using standard equipment and normal moulding techniques, but with operators who were trained to maintain the specified conditions, it was possible to keep the length of a 6-in. test bar to within 95 per cent. confidence limits of ± 0.001 in., *i.e.*, better than 0.0002 in. per in. length. Making parts with this degree of accuracy will be more costly than a similar part made to normal tolerances of about 0.002 in. per in. It is therefore important not to ask the moulder for closer accuracy than is really needed.

Shrinkage

The next problem to consider is design allowance for shrinkage, and here similar factors apply to polystyrene as to wax, except that with the lower shrinkage of polystyrene, one can expect to be within the tolerances allowed for wax. A

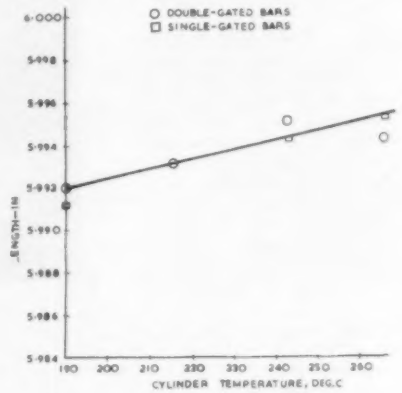


FIG. 4.—*Effect of cylinder temperature on the length of a test piece, injection pressure and mould temperature being held constant.*

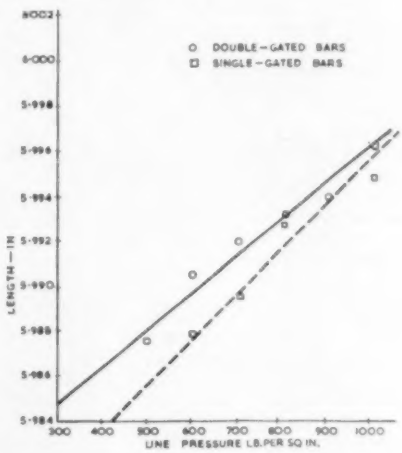


FIG. 5.—*Relationship of injection pressure on the length of a test piece, cylinder and mould temperatures being held constant.*

typical figure would be 0.5 per cent. as compared to 1 to 2 per cent. Moulders usually allow 0.004 to 0.008 in. per in. shrinkage in their designs. The actual figure depends on moulding conditions, for example mould temperature or packing, as explained above. This shrinkage takes place partly within the mould, and partly after ejection (Fig. 6),

but it will be seen from the graph that the seasoning time for a simple moulding is quite short. For mouldings with varying thickness, particularly if the thicker section is more than ½ in., shrinkage becomes a problem. If they are removed from the mould too quickly, warping and sink marks are possible. This is particularly important where close tolerances are required. It is then advisable to take the cooling operation further in the mould, by passing cold water through. This, of course, slows the cycle considerably, and in cases where a close tolerance is not required, and the moulding although thick is of a balanced section, the parts should be produced on the multi-mould machine mentioned previously. The problem is not so serious as with wax, as polystyrene is a tough material, and therefore provided that the surface layers have cooled sufficiently, they will resist the shrinkage forces, and a hollow core will be formed.

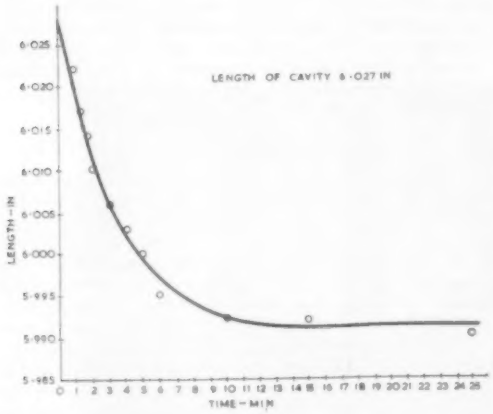


FIG. 6.—*Rate-of-contraction curve followed by a typical test bar on removal from the mould.*

General Properties

Polystyrene is a tough material available in several grades with various properties, typical figures for which are given in Table 2. All of these grades are hard, tough, and give a good finish when moulded, and it will not normally be necessary to use a toughened grade. The choice, therefore, lies between the grades of straight polystyrene, which differ only in their flow and softening points. These grades are transparent, but can be coloured if necessary. The grade chosen will depend on the individual caster's requirements. For example, where a shell is built up round the pattern, it is advantageous to use a grade with a low softening point. It should be noted that most plastics do not have a true softening point, and what is meant by "softening point" in the plastics industry is the temperature at which a test bar deflects by a fixed amount under a fixed load. It can be seen that all grades of polystyrene are stable at normal ambient temperatures, and they are equally unaffected by variations in humidity. Polystyrene mouldings will, therefore, not warp or distort through changes in either temperature or humidity. This is most important at the investment stage, where failure to control shop conditions closely when using wax patterns can lead to faults in surface finish arising from cracking or shrinkage of the dip-coat. Complete rupture of the investment can occur if a shell mould is used, and this is well illustrated by Fig. 7, which shows some strips of wax and polystyrene. These were all coated with refractory to form a shell which was subsequently dried at 60 deg. C. It is quite clear that the effect on the wax samples is disastrous, whereas the polystyrene ones are unaffected. The stability of polystyrene is also important in the earlier stages of the process, and this combined with the high strength, surface hardness and ease of sticking parts together, means that polystyrene patterns can be stocked ahead of demand without risk of damage or distortion, and can be handled and assembled much more quickly than wax without risk of damage. This means that polystyrene patterns are of particular interest for shell moulds.

No difficulty should be experienced in obtaining an even coverage of a polystyrene pattern with a dip-coat based on either a water or alcohol solvent. It may be necessary in the case of the former type to include a small amount of a wetting agent as often done when coating wax patterns. The higher softening point and slower melting characteristics of polystyrene mean that a higher temperature is required for the removal of the pattern than is usual for wax. For example, if a shock melting technique is used, the furnace temperature should be above 900 deg. C., otherwise the expansion of the pattern may fracture the shell.

Overall Appraisal

It would probably be useful at this stage to summarize the advantages and disadvantages of polystyrene as a pattern material, and then consider its likely field of application. Polystyrene has the following features:

(1) Lower shrinkage and thermal-expansion coefficient than wax; (2) it is much tougher and therefore more easily handled ; (3) it is not affected by fluctuations in room temperature or humidity; (4) it can be moulded in most of the shapes possible in wax; (5) moulds will sometimes cost more, and this is particularly true of complex shapes with moving cores; (6) assembly of parts of patterns is much easier than with wax; (7) faster moulding cycles are possible; (8) high accuracy can be obtained when required, but is probably only economic on longer runs to spread out the cost of rejects in the initial stages; (9) owing to its temperature/viscosity characteristics it may be more difficult to burn out than wax.

As will be appreciated it is very difficult to generalize on any moulding technique. However, polystyrene seems to offer sufficient advantages to make it worthwhile overcoming the difficulties in its use as a pattern material. This has certainly been achieved in the US, where considerable quantities of patterns are made in polystyrene, some of

them quite complex in shape. (Members of last year's BICTA meeting will probably remember the many slides shown by Mr. Carr of Precision Metalsmiths Inc.) Some successful work has been done in this country also but mainly in solid moulds. At the meeting will be shown some polystyrene patterns, together with some examples of the mouldings currently being made by the plastics industry in polystyrene. These will illustrate the complex shapes which moulders are used to producing.

The properties of the material must be considered in conjunction with its cost. As a raw material, polystyrene is much cheaper than wax, ranging from about 1s. 11d. per lb. to 3s. per lb. according to grade. Moulding and assembly costs will be lower, but mould costs will be higher (this difference being of less importance on long runs). However, as there is no recovery of material on melt out, comparison with wax depends to a large extent on the amount of re-use each caster manages to achieve with wax, balanced against the above savings. The investment-casting industry is at present expanding, and with the perfection of shell-moulding techniques, may well enter fields where large numbers of castings will be required. This will make the use of polystyrene patterns of special interest.

As explained above, polystyrene can be obtained with widely differing properties. It may well be found that more than one grade will be useful to investment casters, and it is felt that close co-operation between raw-material producer and casters will save a lot of difficulties in early trials.

DISCUSSION

Mr. Waxman's paper formed part of the programme of the second session of the conference when Mr. D. H. Armitage (P.I. Castings (Altrincham), Limited) occupied the chair. The following are extracts from the ensuing discussion.

MR. D. H. FARRIMOND (H. & F. Precise Castings, Limited) opened the discussion by remarking that as this was the first time that they had been given the opportunity to discuss polystyrene as a pattern material, he was interested to find out how many people were using polystyrene.

He was disappointed that Mr. Waxman had not been able to talk about the American-type materials. He had been dealing with the Lustrex general purpose material, Hi-Flow and some of the tougher materials, and felt that the Author had probably missed the point that they were selling castings, and some of the advantages which were present for these materials as mouldings were of no real use and necessity to investment foundries. For instance, the high stability at 90 deg. C. was probably a disadvantage. He was recalling some years ago when some work was originally done in this country with polystyrene as the pattern material. The suppliers had then been persuaded to modify the material in such a way that it burnt out and collapsed more easily than the existing standard type of polystyrene. His company had been in touch with Monsanto over this problem, and whilst they were still awaiting information on the American material, they had done some work with the type discussed in the paper. So far, they had obtained quite good results. They had certainly experienced some flash and cracking, but he felt that this material had to be shock-fired in order to overcome cracking problems. He also pointed out that the cost of the material was related to the quantity used. He understood that wax should be used for runners and feeder heads. For one thing, the wax did come away quickly leaving an ample sized cavity into which the polystyrene could expand and drain away. At the same time, he thought that the dimensional stability, and the sharpness of form of plastic patterns was something to be anticipated, as fine sharp points and edges on wax patterns could well round off with any slight rise of temperature in the wax room.

He asked if the plastics industry was developing other materials, particularly from the point of view of the burn-out; and secondly, whether one could expect a material that could be more easily injected at lower pressures into dies of lesser strength, thus making it economic to consider short runs of one or two thousand parts in plastic patterns as opposed to wax.

Gating

Finally, he commented that he had always been under the impression that pin gates were the only way of feeding polystyrene patterns, but the paper had mentioned open gates. He wanted to know how big was an open gate, adding that when they injected a wax they tried to incorporate the feeder on the wax itself, so that the operator only had to warm the wax feeder on to the runner bar and so not disturb the pattern. Whatever the section fed into, the runner on the gate was going to be bigger. He asked whether one was going to experience trouble in moulding this heavier section on to some thinner section which was the pattern proper and if they were going to experience trouble with shrinkage and contraction at such points. He requested the Author to sum up the situation.

He added a further question as to whether the lady's plastic shoe-heel, which was on show, was

TABLE 2.—*Typical Properties for Various Grades of Polystyrene.*

Grade.	Tensile strength, lb. per sq. in.	Impact strength, ft.-lb.	Softening point, deg. C.	Viscosity at 200 deg. C poises.
Lustrex* G.P. ..	7 to 8,000	0.4	93	6,000
Lustrex Toughened T.7	6 to 7,000	0.7	86	6,500
Lustrex Toughened T.3	5 to 6,000	1.2	83	6,000
Lustrex Toughened T.11..	4 to 5,000	1.8	81	6,000
Lustrex Hi-Flow 55†	5.5 to 6,500	0.5	82	4,500
Wax	3 to 400		20	5 to 150 70 deg. C.

* Lustrex is a registered trade mark.
† A new grade with even-lower viscosity, and softening point—available for evaluation only, at present.

injected from the narrow end, the wide end, or somewhere in the middle.

MR. C. H. WAXMAN replied as follows. On the first point about American material, they had been in quite close contact with their American company on this matter and their information was that different investment casters in the US used different grades of material. Some of them used a material which was identical with Monsanto GP material; some used a material which was also identical with Monsanto Hi-Flow material and others used material with an equivalent softening point.

He continued that the point made about stability at 90 deg. C. was perhaps over-emphasized. He had merely been trying to highlight the stability of the material at ordinary temperatures. Nevertheless, the high softening point material, which one company in the US used, was very similar to this material. This was a toughened version of it. Therefore, the question of easy melt-out from the mould was not the only factor which made people choose a certain grade. In reality, he considered that the grades available in this country covered the range used in the US.

The question of the modified material raised was quite an interesting one. A low molecular-weight polystyrene could be produced which would be easier to mould and easier to melt out, but unfortunately (from the investment casters' point of view) the plant available for making polystyrene was rather large to make the production of a special material such as this worthwhile A demand of something like two or three thousand tons per annum would be necessary and he doubted whether the industry's requirements would be likely to meet that.

MR. D. H. FARRIMOND commented that the material which they had used at one time was of a modified rubber consistency.

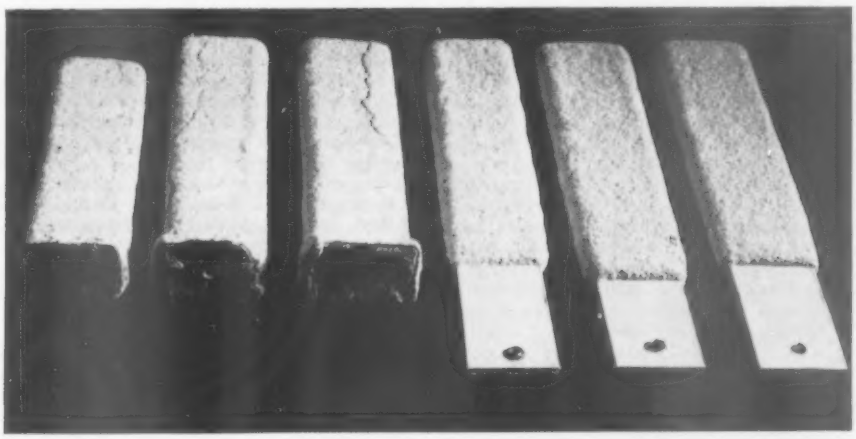
MR. C. H. WAXMAN replied that this would be similar to their present toughened grade, but the softening point as measured by their normal process was only about 10 deg. C. less than that of the GP material, and the toughened grades were somewhat more expensive. They had about four or five different versions of the material available and he invited any of the foundries to experiment with them.

Foam Runners

Regarding the use of wax runners, the point was quite valid, particularly as the quantities of runners required were very much less than that of the patterns and therefore it probably would not be worth moulding them. This problem could be overcome by using polystyrene foam and removing it by solvent. This was quite simple because foam density was about one or two lb. per. cu. ft., and consequently the amount of material which needed to be removed was negligible. The foam had simply to be exposed to the vapour and it disappeared. The economics of this method could be quite interesting, even though no re-use was possible. However, to obtain the surface required on the runners, in order to get good flow with the investment and so forth, they would have to be moulded not in the normal type of injection machine, but in a pressure mould using steam heating. The foam was moulded by steam rather than by melting it.

Regarding the question of the size of the gates, he had deliberately left the matter a little vague in the paper because the open gate could be

FIG. 7.—*Shell moulds produced for investment casting, and dried at 60 deg. C. Cracks may be observed on the three left-hand shells made from wax patterns, whereas the polystyrene ones are unaffected.*



as large as was necessary to feed the moulding. If the liner for a refrigerator was being produced, for instance, one might imagine that the gates for that would be quite massive. It was thus very difficult to be specific on this point. On a normal sort of moulding, such as had been illustrated, an open gate should be perhaps ¼ to ⅜-in. across and about $\frac{1}{16}$-in. deep.

The speaker rejected Mr. Farrimond's suggestion that the aim should be one gate, adding that the magnetic-tape spools which had been shown had four pin-gates, one in each segment, and one could see the points of these gates if one looked closely.

With regard to wax runners, he showed a small casting made from a polystyrene pattern and which had attachment points moulded into it. It had been moulded on the same die which was normally used for wax so that one could see the question of moulds was not quite so serious on short runs as one might think. The only thing, of course, was that if a soft mould was produced for a short run it would be useless for producing a longer run later. Customers generally said, " I only want 500 of these," and then six months later they order another thousand, and then the foundry is probably in difficulty. Mr. Waxman then showed two shoe heels, both gated at the end. These had been produced quite fast using one of the grades of polystyrene discussed, and in fact, could be produced one every 10 to 15 seconds. Only part of the cooling was done in the mould and use was made of either rotary machines where the mould went round and cooled in air whilst more were being moulded or e'se they were dumped in water and cooled. The great advantage of polystyrene in thick sections was that it was such a tough material that once the skin had formed any shrinkage came outwards instead of pu'ling the surface inwards. Therefore, if it was cooled too quickly, one could finish up with a void inside the moulding. This was of importance to plastic moulders but in this application would not matter.

Cost

MR. A. DEACON (D. Napier & Son Limited) commented that for the last 15 years or so his company had been seeking a better wax and it was, therefore, particularly interesting to know that another material was coming into the industry. Nevertheless it appeared that there were quite a number of disadvantages in using polystyrene. Most of the delegates came from jobbing foundries, where the general run of enquiries was for 200 to 500 components. Using polystyrene he did not see that the cost of dies for injections was going to be very acceptable to their customers, when they could get a soft dies for £60 or £70. To use polystyrene patterns the dies were going to cost £200 to £300 or even more. He added that Mr. Waxman had also mentioned that it took a couple of hours to get the machine running, but it might then take only half an hour or so to run the order after that. He added that his firm had found the tendency for more cracking of the she'l on burn-out. That might be because they had concentrated their efforts on wax and altered their processing to suit the wax. It might be that they would have to alter the process if they went over to polystyrene. Another point made by the questioner was the high cost of the injection machinery. A two-to-four-ounce machine to turn out a spray of polystyrene patterns might cost £5,000 or £6,000, and they could not afford to have such machines which might have a long setting-up time simply for small runs. The wax machine cost so much less and the dies were easy to change. Again the point of the overall cost of the material was touched on. Mr. Deacon stated that it was normal practice to reclaim part of the wax but with polystyrene, all the material would be lost. In spite of all this, there were advantages the greatest of which were, he thought, the easy storage of patterns and their handlability. Some operators could produce many breakages in the wax-stripping operations, and unless one had a temperature-controlled room, a considerable amount of distortion with wax patterns could be obtained.

Economical Quantity

MR. C. H. WAXMAN agreed that small quantities were not really economical in polystyrene but the term " small quantities " required qualification. If one was going to require 500 or 1,000 this week and another 500 or 1,000 in six month's time it was a slightly different problem. He explained that the two-hour setting up time which he had mentioned only applied in the instance where extreme accuracy was required. If there was a skilled operative on the job and he knew what he was doing, knew the tool and so on, it was possible to get the conditions right in a much shorter time than two hours. In the case of a fairly large moulding, say a 4- or 8-oz. shot, if it was near the top capacity of the machine, only one or two shots a minute would be possible so that it was going to take more than two hours to run off the quantity required, unless it was only about 50; but neither did he think that it would be economical to do 50 injections in wax. The problem of cracking was quite an important one in shells, and as far as could be seen it did depend to some extent on the type of shell, its thickness, the strength of it and so on, and also on the shape to be produced. The machines were fairly expensive, but it had to be borne in mind that one polystyrene machine could produce the same number of patterns as could one and a half or even two wax machines. He considered that a four-ounce machine would not cost more than about £3,500. When the machine was given a write-off time of five to 10 years it was not a great outlay, always provided that the foundry had the use for it.

MR. N. WALKER (Hadfields, Limited) asked if he could pursue the question of accuracy. His firm had put out enquiries to commercial moulders and found that the accuracy which they were prepared to offer was very far short of the accuracy mentioned in the paper. They had been offered quite small patterns to an accuracy of plus or

minus 0.0025 in. which was a very considerable part of the total accuracy to which they were attempting to produce castings. He asked whether this experience was representative of the industry, or whether to achieve the degree of accuracy considered necessary would impose considerable premiums in the way of cost.

Secondly, on the question of the cracking of shells, the Author might already have answered this question by saying that he did not have a lot of experience of this, but it did seem necessary that one had to match the expansion characteristics of the filler of the shell with the expansion characteristics of the polystyrene.

Thirdly, on multiple-cavity injections it seemed that the quality of the injections might be quite adequate for most purposes for which polystyrene was used, but for their purpose he asked whether the general quality was sufficiently high so that they would not need to discard any patterns from a sprue containing a number of injections.

Accuracy

MR. C. H. WAXMAN replied that he thought that accuracy and commercial life did not necessarily go together. In the average moulding shop there was a wide range of machines, jobs and operatives doing these jobs. If one wanted an accurate work the moulder would probably have to put one of his best men on the job, which meant that he was not available for prototype work and helping out when a machine was in trouble, and so on. Therefore, many moulding shops would not be terribly keen to take on a highly-accurate job unless the purchaser was paying a lot for it. If the bulk of any foundry's work consisted in jobs to very-close tolerances it would pay them to produce their own mouldings because then they would have the situation entirely under their own control. If they had a reasonable quantity which they wanted doing accurately there were quite a few moulders who were capable and willing to carry out this class of work. This was not necessarily somebody whose bulk of production was in polystyrene, because most polystyrene work was for consumer goods, not made to these high tolerances. There were, however, moulders who made parts to close tolerances, such as nylon washers and these were subject to AID inspection.

MR. WAXMAN then referred to the influence of expansion on the cracking of shells. This was one aspect where there was probably room for a certain amount of research. Variable expansion might have something to do with cracking troubles. On the other hand it might be that the gases given off were causing the trouble rather than the expansion of the polystyrene itself. Of course, the polystyrene expanded much less than did wax. He had calculated that one would have to take polystyrene up to about 700 deg. C. in order to get the equivalent expansion one got from wax up to its melt-out point. On this basis, he considered that there must be something else involved.

In multi-impression work accuracy was a function of the tooling. Provided the gates were set right he considered that one could be sure of accuracy from the different impressions. When the tool first arrived from the toolmakers it might be necessary to experiment with the gates to make sure that the feed to each cavity was right. Once the trouble had been corrected it would remain true.

MR. N. WALKER added that he had not been thinking so much of the dimensional accuracy, because obviously the numbers required to justify this tooling would be so high that the measuring of each pattern might become impracticable. He was thinking largely of the surface condition of them and asked whether he was to assume that the pressures involved were such that flow lines and that type of thing would not occur.

MR. C. H. WAXMAN replied that he had seen moulding in multi-cavity work where flow lines did occur, but generally speaking one could overcome them by altering the techniques.

MR. I. L. GWYNN (P.I. Castings (Altrincham), Limited) questioned the Author further about multi-cavity dies, asking if it would be necessary to make different sizes of cavity in order to get the same size of pattern. This was something which one did experience in wax pattern production. With regard to deep cavity work he asked whether it were necessary to have a draft angle in the dies.

MR. WAXMAN answered that one could assume that it was necessary to have a draft angle on a deep cavity. He thought the figure was about three degrees. On multi-impression tools one generally had a fairly hefty runner. In the case of one tool on which he had worked recently, which was an eight cavity model, the sprue and runner systems had been one-third of the total weight. If the runner system were properly designed the material should enter each cavity at roughly the same temperature, so that the differences in cavity size were probably very small. It would, howevr, depend to some extent on the efficiency of the cooling system.

MR. R. WAINDLE (WaiMet Alloys, US) said that there was an additional incentive to the use of polystyrene patterns in moulding techniques which had not been mentioned. In the US they were quite accustomed to making prototypes by machining polystyrene, assembling various machined parts by the use of solvents for the plastic, and then using those as patterns for making prototype castings. This was a very important incentive for becoming accustomed to the use of polystyrene patterns in moulding techniques.

Internal Stresses

MR. A. DUNLOP (Jessop-Saville, Limited) pursued the question of accuracy a little further, stating that it was all very well to have something which was dimensionally stable to heat once it was out of the mould, and to hear of these close tolerances on a section which was evenly balanced, but in making, say, a turbine blade aerofoil section, 4-in. long, 2-in. wide and about 0.4-in. in thickness in the centre tapering to 0.010 in. at the

Polystyrene, a Material for Patterns

trailing edge, troubles were encountered. The speaker's company had produced steel dies to a high degree of precision and the injections had been done by a professional injection moulder. When the parts came back they were well made strong and robust but the trailing edges were at least 0.050 to 0.060-in. bent. When these blades were examined under polarized light—a photo-elasticity test was carried out—the patterns were full of locked-in stresses. He asked how the problem of distortion was overcome when uneven sections were encountered.

MR. WAXMAN replied that Mr. Dunlop had brought up one of the perennial problems of any moulding technique. He had stated in the paper that polystyrene was less prone to shrinkage and distortion problems on thick or varying sections, but that did not mean to say that there were no problems. It was inherent in any melt moulding process that in certain circumstances, one could get locked-in stresses. He considered that in many cases it was possible to get over this trouble by appropriate moulding techniques: for instance, by making sure the material was hot enough so that it flowed easily into the mould without stress and by making sure the mould was hot enough so that it did not cool the material down too quickly. One could, to some extent, overcome these problems and they were easier to overcome in polystyrene than wax because of the much-lower co-efficient of thermal expansion of the polystyrene, but he would not like to say that they could be completely eradicated.

News in Brief

AN ENGINE BOILER of 7-ft. dia., made in the 1790s, has been sent to the London Science Museum from Denby Hall Colliery, Derbyshire.

A NEW SUITE OF OFFICES at Berkeley Square House, London, W.1, has been taken over by Leyland Motors, Limited, to house the headquarters of the group's sales organization.

FROM MONDAY, DECEMBER 18, the Swansea branch office of Brook Motors, Limited, will be at Orchard House, Orchard Street, Swansea. The new telephone number will be SWA 50297.

THE DAVY ASHMORE GROUP has decided not to send out Christmas cards this year, but to give instead a donation, equal to the amount spent on cards in previous years, to a recognized charity.

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS announce that their air show at Farnborough will be held as usual next September, but that there will be no exhibition in 1963. It will resume in 1964.

MORE SPECIAL STEEL IN NSW—Output of special steels at Port Kembla, NSW, has been increased recently by the commissioning of a second electric-arc furnace, of 45-ton capacity—claimed to be the largest in the southern hemisphere.

AN ORDER for a 17-knot cargo liner has been secured by the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, from the Bibby Line for use on their Burma and Ceylon service. The new vessel will be equipped with Fairfield Sulzer-type diesel machinery.

QUALCAST, LIMITED, Derby, who recently started a four-day week at one of their foundries, will now resume a five-day week. The firm, which *inter alia* makes castings for the motor trade, reveals that full-time working has been resumed because of a general improvement in trade.

FOUR ROTAIR rotary-screw-type compressors for Metalexport the Polish State purchasing agency have recently been shipped to Gdynia, Poland, by Holman Bros., Camborne, Cornwall. A further unit, shipped direct from the Holman stand at the Brno Fair, is already working in Poland.

TAYLOR'S FOUNDRY, LIMITED, moved on Monday last to commence operations in its new foundry in Suffolk, and from that date, the registered office is at Hollands Road, Haverhill, Suffolk. The premises at Alperton, near London, are being retained and castings production is also continuing there.

THE STEEL MANUFACTURING TOWN of Que Que has moved up to become the fifth largest European population centre in Southern Rhodesia. Preliminary totals recently published of a census held in September show that there are now 3,020 Europeans in the town, compared with fewer than 2,000 in 1956.

J. G. STATTER & COMPANY, of Amersham, a member of the Metal Industries group, is to supply extension switchboards and units for use with switchgear already supplied to the Sheikdom of Kuwait. The order is valued at £13,400 and brings to more than £350,000 the amount of equipment ordered by Kuwait over the past three years.

AN ORDER for a 6,000-ton troop and tank carrier, worth £1,750,000, has been placed with the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, by the Ministry of Transport on behalf of the War Office. The ship may be the first of a number intended to replace the present landing craft, which are now regarded as obsolescent.

MR. WILLIAM WALKER has resigned from the managing directorship of Atlas Steel Foundry & Engineering Company, Limited, Armadale, West Lothian, but retains his seat on the board. MR. ALEXANDER WALKER succeeds him as managing director, and Mr. A. SCOTT, formerly of K & L Steelfounders & Engineers, Limited, Letchworth, becomes general manager.

A TWO-DAY COURSE on "Cathodic Protection—Instrumentation, Interference and Interference Testing," intended for workers in the field of corrosion who are particularly interested in problems associated with cathodic protection in practice, is to be held by the metallurgy department of Battersea College of Technology, London, S.W.11, on December 19 and 20. The fee for the course is £6.

TWO GLASGOW MEN—Mr. Daniel Quin and Mr. Thomas Boyd—are supervising the erection of mechanical-handling equipment for a radiator foundry in Bucharest, Rumania. They are employed by Paterson Hughes Engineering Company, Limited, suppliers of the equipment. Their part of the job will cost about £250,000 and the men will be in Rumania for six months.

ORDERS FOR MORE than 25 Microscan X-ray analysers, worth approximately £500,000, have been received by the Cambridge Instrument Company, Limited, Grosvenor Place, London, S.W.1, within two years of production of the first instrument. Just under 50 per cent. of these orders have come from abroad, and to increase this proportion the company have

initiated a number of "hard sell" visits to major European cities.

THE DIRECTORS OF COLVILLES, LIMITED, have given £25,000 to the Royal College of Science and Technology, Glasgow, for the purchase of a high-speed transistorized computer. Dr. S. C. Curran, principal of the college, said it would be of a type which can be added to and will be available to industry in the West of Scotland. Ferranti Limited, Edinburgh, makers of the computer, are also to make a contribution towards the cost.

THE BRADFORD DYERS' ASSOCIATION, LIMITED, Bradford, have placed an order with W. H. Allen Sons & Company, Limited, Bedford, for turbo-generating equipment for duty in the works of a subsidiary, the Standish Company, Limited, of Wigan. The plant will comprise two 800-kw geared, back-pressure turbines each driving an Allen 3.3-kV alternator at 1,500 r.p.m. through an Allen-Stoeckicht epicyclic speed-reduction gearbox.

CALLENDAR ABBOTS FOUNDRY has been closed down as part of the reorganization scheme in the Allied Ironfounders Northern Group. Work has been transferred to Castlelaurie Foundry, Falkirk. The transfer has taken place over the past few weeks and does not affect the number of those employed. The main products involved are rainwater and soil pipes. It is proposed to retain at least part of the Callendar Abbots works for future products which the Allied group have in mind.

THE ASSOCIAZIONE ITALIANA DI METALLURGIE announces that the next congress will be held in Naples in the autumn of next year. The general theme is to be the working of metals to include plastic working, mechanical handling and heat-treatment. Those who intend to submit papers, should have them ready for despatch by next March. Details of the conference are available from Dr. Pinto at the Association's headquarters, 10 Via del Politechnico, Milan, Italy.

POWER-GAS CORPORATION, LIMITED, a member of the Davy-Ashmore group, has secured an order from the Hong Kong & China Gas Company for a Wiggins dry-seal gasholder, with a capacity of 1,000,000 cu. ft. of town gas. This will be the 100th production of these gasholders since their manufacture was started in 1950. Gasholders of similar capacity are being made at present by the firm at the Clyde Ironworks of Colvilles, Limited, and at the Rhondda works of the Wales Gas Board.

THE AUTUMN GENERAL MEETING of the Lorry Mounted Crane Association—membership of which now stands at 38 full members and eight associates—was held in London on November 28. Discussion ranged over a wide field and a technical committee was formed consisting of qualified engineers and members with field experience. It was decided to hold the annual general meeting in London in May, 1962, on a date which would enable members to visit the Mechanical Handling Exhibition.

THE SOUTH AFRICAN ANTI-SUBMARINE FRIGATE S.A.S. "President Steyn" was launched on November 23 at the yard of Alexander Stephens & Sons, Limited, Glasgow. It is the second of three anti-submarine frigates of the Rothesay class now being built for the South African Navy in Glasgow shipyards—the first, "President Kruger," was launched in October, 1960, while the third, "President Pretorius," will be launched next year. They are being fitted with the latest underwater detection equipment and anti-submarine weapons.

THE BRITISH INDUSTRIAL TRUCK ASSOCIATION is offering as first prize in its annual competition a place at the ninth material handling training course—a two-week course in the theory and practice of materials handling at an advanced level—to be held at Lake Placid, USA, in June 1962. The competition, which is to be held shortly, is open to all those having a responsibility for the movement, handling, stocking and controlling of materials. Full particulars may be obtained from the Association at York Mansion, 94/98, Petty France, London, S.W.1.

LOEWY ENGINEERING COMPANY, LIMITED, of Bournemouth, a member of the engineering division of Tube Investments, Limited, has received an order from France valued at over £100,000 for a 1,200 tons oil-hydraulic free-forging press. The press will be capable of working at high speeds to extremely accurate limits and is equipped with eletronic-thickness control; it will be integrated with a rail-bound manipulator. This plant is one of five free-forging installations from 600 to 4,000 tons capacity with a total value of over £750,000 at present on order with the company.

A PROGRESS SURVEY of the National Industrial Fuel Service, an independent non-profit-making organization sponsored by the nationalized fuel undertakings and two oil companies, reports how the efficiency of a number of drying stoves at the Middlesbrough foundry of W. Shaw & Company, Limited, was improved so that savings of more than £1,000 a year resulted. At Shaw's Wellington Foundry the fuel service increased overall efficiency of the stoves from 23.4 per cent. to 39 per cent. The survey includes the case histories at a number of other North-east firms.

"TECHNICAL READING—BUGBEAR OR BOON?" was the title of a conference arranged by Sheffield Interchange Organization at the Mappin Hall, Sheffield, last month. A scheme to provide a post-graduate school of librarianship at Sheffield University, announced by the Vice-Chancellor of the University, Dr. J. M. Whittaker, would probably necessitate the setting up of a new university department, it was stated, and the cost of new premises would be in the region of £30,000. It was hoped that the first students would be in the new department by the autumn of 1963.

NEW ZEALAND'S FIRST ALUMINIUM ROLLING MILL, the £2,500,000 Alcan Industries, Limited, plant at Wiri, Auckland, was officially opened by the New Zealand Prime Minister, the Right Hon. K. J. Holyoake, on November 14. The plant has an initial capacity for the annual production of 5,000 tons of aluminium sheet and plate, and will be able to meet virtually the whole of the country's present requirements of material of this kind. The new mill forms the New Zealand branch of the United Kingdom company, Alcan Industries, Limited (a member of the Aluminium Limited of Canada group of companies).

BOWTHORPE HOLDINGS, LIMITED, Crawley, Sussex, announce that they have reached agreement with the Deutsch Company of Banning, California, to the formation of a new jointly-owned company—Hellermann Deutsch, Limited—in which Bowthorpe Holdings will have 51 per cent. interest. The new company will manufacture and market the range of Deutsch connectors for electrical conductors and other products at present being produced and marketed by the connectors division of Hellermann, Limited. A factory for Hellermann Deutsch, Limited, to be completed during 1962, is planned for East Grinstead, Sussex. Production of Deutsch connectors will commence in the UK early in 1962.

British Blast Furnaces in the September Quarter, 1961

(These tables are published through the courtesy of the British Iron and Steel Federation.)

Derbyshire, Leicestershire, Notts, Northants, and Essex.

Name of firm.	In blast at end of the third quarter, 1961.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Ford Motor	—	—	1	—	1	1	1
Holwell Iron	—	—	1	—	1	1	2
Renishaw Iron	—	1	1	—	2	2	2
Sheepbridge	—	1	1	—	2	2	2
Stanton Ironworks: Stanton-by-Dale	—	—	4	—	4	4.4	5
Staveley Iron & Chemical	—	—	3	—	3	3.6	4
Stewarts and Lloyds: Corby	—	3	—	—	3	3.7	4
Wellingboro' Iron	—	1	—	—	1	1	3
TOTAL	—	6	11	—	17	18.7	24

Lancashire (excl. N.-W. Coast), Denbighshire, Flintshire, and Cheshire.

Brymbo Steel Works	—	1	—	—	1	1	1
Darwen & Mostyn Iron	—	—	—	2	2	2	2
Lancashire Steel Manufacturing	—	2	—	1	3	3	4
Summers, John	—	2	—	—	2	2	2
TOTAL	—	5	—	3	8	8	9

North-West Coast.

Barrow Ironworks	2	—	—	—	2	2	2
Charcoal Iron	—	—	—	—	—	0.2	1
Millom Hematite Ore & Iron	2	—	—	—	2	2	3
United Steel: Workington	2	—	—	—	2	2	3
TOTAL	6	—	—	—	6	6.2	9

Lincolnshire.

Appleby-Frodingham Steel	—	3	—	—	3	3.8	4
Lysaght's Scunthorpe Works	—	3	—	—	3	3	4
Thomas, R., & Baldwins: Redbourn	—	3	—	—	3	3	3
TOTAL	—	9	—	—	9	9.8	11

North-East Coast.

Consett Iron	—	2	—	—	2	2	3
Dorman Long (Steel): Acklam	—	2	—	—	2	2	4
Redcar	—	—	—	—	—	—	2
Bessemer	—	1	—	—	1	1	3
Clay Lane	—	2	—	—	2	2	2
Gjers Mills	2	—	—	—	2	2	3
Skinningrove Iron	—	2	—	—	2	1.9	3
South Durham Steel & Iron: West Hartlepool	—	2	—	—	2	2	3
Cargo Fleet	—	2	—	—	2	2	3
TOTAL	2	13	—	—	15	14.9	26

Scotland.

Bairds & Scottish Steel: Gartsherrie	1	—	—	—	1	1	4
Carron	—	—	1	—	1	1	2
Colvilles: Clyde Iron Works	—	3	—	—	3	3	3
Ravenscraig	—	1	—	—	1	1	1
TOTAL	1	4	1	—	6	6	10

South Wales and Monmouthshire.

Guest Keen Iron & Steel: Cardiff	1	2	—	—	3	3	4
Thomas, R., & Baldwins: Ebbw Vale	—	3	—	—	3	3	3
Steel Company of Wales: Margam	—	5	—	—	5	5	5
TOTAL	1	10	—	—	11	11	12

Leyland Extension

A new £170,000 extension has been completed at the headquarters' service factory of Leyland Motors, Limited, at Chorley, where 60,000 sq. ft. of floor space has been added to bring the total covered area to some 140,000 sq. ft.

Construction of the extension, which incorporates five storage bays and a goods receiving and dispatch bay, was undertaken by Leyland Construction Company, Limited, and Holland and Hannen and Cubitts (North West), Limited. It was designed by Leyland Motors' works engineering department. Each of the five storage bays is 225-ft. long by 42-ft. wide and all have electrically-operated doors. The dispatch bay is 210-ft. long by 60-ft. wide, and all the bays have an average height to the eaves of 28 ft. They are heated by Mather & Platt unit heaters which incorporate electric fans. When the steam supply is isolated, the units can be used for air circulation.

More expansion is allowed with this new extension which houses packing cases of large assemblies and bulk orders for export, heavy units, unit stores and remanufactured units.

A SERIES OF TWO ONE-DAY SEMINARS, concerned with techniques in evaluating future job performance and determining manpower capabilities, are being held in Birmingham, Manchester and London, in January, 1962, by Industrial Education International, Limited, from whom details may be obtained at 66, Chandos Place, Strand, London, W.C.2.

BPA Display

Birmingham Productivity Association outlined, on November 27, plans for an exhibition at Bingley Hall in May next designed to show the advances being made by industry in new production methods and automation.

It was stated that the exhibition will be the largest yet held in the UK to be devoted exclusively to industrial research and productivity. More than 75 per cent. of the exhibition space has already been booked. The Department of Scientific and Industrial Research as well as other research bodies had taken stands and Continental firms were showing interest. The Rover Company, Limited, and the Austin Motor Company, Limited, will, it was stated, feature the development of industrial gas-turbine engines.

Concurrently with the exhibition there will be, from May 23 to May 31 a series of conferences on relevant subjects.

British Blast Furnaces in the September Quarter, 1961—*continued*

Staffordshire, Shropshire, Worcestershire, and Warwickshire.

Name of firm.	In blast at end of third quarter, 1961.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Goldendale Iron	—	—	1	—	1	0.8	2
Shelton Iron & Steel	—	2	—	—	2	2.7	3
Stewarts and Lloyds: Bilston	—	1	—	—	1	1	2
TOTAL	—	3	1	—	4	4.5	7
Sheffield.							
Park Gate Iron & Steel	—	1	—	—	1	1.7	2
GRAND TOTAL	10	51	13	3	77	80.8	110

Weekly Average Number of Furnaces in Blast during the September Quarter, 1961, and the Previous Four Quarters

District.	1960.		1961.		
	Sept.	Dec.	March.	June.	Sept.
Derby, Leics., Notts., Northants, and Essex	20.3	20.1	20	20	18.7
Lancs. (excl. N.-W. Coast), Denbigh, Flint, and Cheshire	6.9	7	7	7.9	8
Lincolnshire	9.3	10	10	10	9.8
North-East Coast	17.6	17.9	17.7	16	14.9
Scotland	7	7	7	7	6
Staffs., Shrops., Worcs., and Warwicks.	5	5	5	5	4.5
South Wales and Monmouth	10	10.2	10	10·2	11
Sheffield	2	2	2	1·9	1.7
North-West Coast	7	7.8	8	7·6	6.2
TOTAL	85.1	87	86.7	85·6	80.8

The following companies have furnaces in course of construction or rebuilding:—Dorman Long (Steel); South Durham Steel & Iron Company, West Hartlepool Works; Colvilles, Ravenscraig Works; Ford Motor Company; Barrow Ironworks; and R. Thomas & Baldwins, Spencer Works (two furnaces).

Industry in the Midlands

The general rate of production in the Midland region still tended to slacken, it was reported at a meeting in Birmingham on November 28 of the Midland Regional Board for Industry. At the Press conference following the meeting, Major C. R. Dibben, chairman of the Board, said that order books were shortening, profit margins were narrowing and the supply of labour was easier. He said, however, that although the gradual slackening of momentum has induced an increasingly cautious outlook in Midland industry, closer examination showed that not all industries were equally affected. The Board agreed that demand from both home and foreign markets could reasonably be expected to expand in the spring though the longer present trends persist, the longer it is likely to take to reverse them. The Chancellor of the Exchequer was urged not to continue the credit squeeze a moment longer than he considered vital.

It was stated that the number of wholly-unemployed workers in the Midlands had risen in the past month by 1,547 but a drop in the total registered as temporarily stopped off had off-set the increase and held the total overall at around 39,350 with the unemployment rate at 1.7 per cent., which is the national average. It was estimated that about 35,000 workers in the region were on short time, 21,000 of them in the motor industry.

Activity remained at a reasonable level in general engineering though below the peak established earlier this year. The machine-tool industry was still busy and so were the civil engineering and building industries. The position in some car factories looked brighter and not all component manufacturers had suffered as much as might have been expected.

Swedish/Finnish Ironworks

Koverhar Iron Works—a joint venture of the Swedish Stora Kopparbergs Bergslags A.B., group and of the Finnish Vuoksennika concern—was expected to start production during November. The Koverhar Works will supply phosphorus-free pig-iron to the parent companies at an expected annual rate of 250,000 *tonnes*.

Iron-ore is to be mined from the Jussaroe deposit—an under-water field in the Baltic. Initial mining capacity will be 300,000 *tonnes* of ore from which 110,000 *tonnes* of concentrate will be processed. While the exact extent of the ore body is not known, some 200,000,000 *tonnes* are indicated, with an Fe-content of 22 to 35 per cent.

WILSON'S FOUNDRY, LIMITED, of South Church Road, Bishop Auckland, are to erect a new electric arc furnace at their factory.

British and World Shipbuilding

Steamships and motorships of over 100 tons gross under construction in Great Britain and Northern Ireland at the end of September, according to Lloyd's Register of Shipping returns, totalled 237 ships of 1,550,857 tons gross. This is 63,205 tons less than the previous quarter and is the lowest figure since September, 1945. It represents a fall of 34 per cent. from the highest post-war figure of 2,345,408 tons at the beginning of 1958. The total of all countries abroad, which has risen during the past quarter, shows a fall of only 9 per cent. from a peak figure of 7,906,658 tons in September, 1958. The total comprises 92 ships of 524,487 tons fitting out afloat and 145 of 1,026,370 tons still to be launched.

Commenced during the September quarter were 54 ships of 214,403 tons; launched, 54 of 182,893 tons, and completed, 58 of 284,418 tons. In Commonwealth countries there were under construction eight steamers of 65,462 tons and 45 motorships of 132,057 tons. Oil tankers building in this country total 38 ships of 746,920 tons, which is 36,043 tons less than last quarter and represents 48.2 per cent. of the total tonnage under construction.

Table 1 shows total construction in the principal districts.

TABLE 1.—*Shipbuilding Construction in Hand in Principal Districts of Great Britain and Northern Ireland.*

District.	September 30, 1961.		June 30, 1961.		September 30, 1960.	
	No.	Gross tonnage.	No.	Gross tonnage.	No.	Gross tonnage.
Aberdeen ..	11	9,509	11	8,265	15	8,255
Barrow ..	3	84,500	3	84,500	3	92,500
Belfast ..	7	115,668	9	135,500	11	197,970
Bristol ..	3	2,413	2	2,250	2	1,930
Clyde:						
Glasgow ..	40	332,859	41	341,618	54	424,226
Greenock ..	18	131,942	18	118,002	19	134,488
Dundee ..	3	12,000	3	9,400	4	12,614
Hartlepool ..	1	8,850	1	9,200	2	22,250
Hull	36	15,245	37	14,742	33	12,938
Leith	7	40,570	8	36,085	6	42,220
Liverpool ..	9	99,477	8	99,080	7	92,540
Middlesbrough	9	155,655	8	143,655	8	146,010
Newcastle-upon-Tyne	31	278,752	29	325,777	33	331,440
Southampton	3	1,370	4	2,875	11	11,040
Sunderland ..	23	254,686	25	275,790	20	215,162

Sizes of steamships and motorships under construction at the end of September in Great Britain and Northern Ireland included the following:—100 to 500 tons, steam nil (motor 88); 500 to 1,000 tons, steam 4 (18); 1,000 to 2,000 tons, steam nil (17); 2,000 to 4,000 tons, steam 2 (2); 4,000 to 6,000 tons, steam nil (12); 6,000 to 8,000 tons, steam nil (11); 8,000 to 10,000 tons, steam nil (4); 10,000 to 15,000 tons, steam 3 (29); 15,000 to 20,000 tons, steam nil (5); 20,000 to 25,000 tons, steam 3 (1); 25,000 to 30,000 tons, steam 5 (nil); 30,000 and under 40,000 tons, steam 10 (nil); 40,000 tons and above, steam 3 (nil).

Apart from the Republic of China, East Germany and the USSR (from which countries no returns are available), there are under construction in the world 1,508 steamships and motorships of 8,788,335 tons, of which 17.6 per cent. is being built in Great Britain and Northern Ireland. The present total is 10,148 tons less than last quarter.

Of the steamships and motorships under construction throughout the world at the end of September, 4,255,496 tons (48.4 per cent.) are to be classed with Lloyd's Register. Of this total 1,466,546 tons, representing 94.6 per cent. of the tonnage being built there, are at yards in Great Britain and Northern Ireland.

Wages and Productivity

At its meeting on November 27 the Birmingham Chamber of Commerce urged full support for the pay pause and stressed the need for a new wages policy to link pay levels with national productivity. It was decided to submit these views to the Association of British Chambers of Commerce at national level with the recommendation that they should be emphasized to the Chancellor of the Exchequer when he comes to deal with the 1962 Budget. Mr. J. J. Gracie, president of the Chamber, said that only by basing industrial awards on increased productivity would it be possible to keep prices stable, increase the spending power of wages and maintain competitive success in export markets.

Mr. K. J. Milligan, chairman of the Taxation and Law Committee, said the price factor would be even more important when Britain joined the Common Market. When a wages policy on a sound basis had been evolved, then the whole fiscal system of the country should be reviewed. In particular, there appeared to be a case for a greater reliance on indirect, rather than direct, taxation as a means of raising revenue. Mr. Milligan said that Britain might well make a study of the indirect-tax systems operated by several European countries; nearly all those countries were in a strong industrial position though that might be purely coincidental. Many members of the Chamber would like to see the tax system widened over a larger range of goods with the possibility of easing the burden on certain products.

At the same meeting, the Birmingham Chamber approved its Transport Committee's report which urged support of a Channel bridge rather than a Channel tunnel to improve transport links with Europe.

SCI Conversazione 1962

The 1962 Conversazione of the corrosion group of the Society of Chemical Industry is to be held at 14, Belgrave Square, London, S.W.1, on March 21. Exhibits from members will form the background and offers to supply material illustrating current research and development are now invited. The main objective of the Exhibition is to stimulate informal discussion of new methods, new results, and unsolved problems. Offers to exhibit, which need not be in detail at this stage, should be sent as soon as possible to Mr. E. E. White, British Iron and Steel Research Association, 140, Battersea Park Road, London, S.W.11.

Russian Technical Books: Collet's Scientific Bookshop (23, Museum Street, London, W.C.1) state that they are now receiving so much technical and scientific material from the USSR that their new catalogue of titles coming within the physical and technical sciences, will be published in three parts. The first part is now available and it contains some 650 titles under the broad headings: civil engineering, mechanical engineering, metallurgy, fuels and transport. Appropriate dictionaries are also listed. Out of 115 titles listed in the metallurgy section, 19 would seem to have major interest to foundrymen.

ARMCO Chile, a company established recently by the US ARMCO International Corporation and a Chilean firm, Compañia Electro Metalúrgica, has opened its new works near Concepción. The first of its kind in S. America, it will use raw steel from the Huachipato works for the production of balls for crushing or milling ores. Its output (initially about 18,000 tons per annum) will supply the needs of the large Chilean copper-mining concerns and there will be sufficient capacity to meet other requirements.

Raw Material Markets

Iron and Steel

The trading position at the iron foundries is much the same as in recent months, and overall demands for castings show little improvement. The engineering and speciality foundries maintain steady outputs of high quality castings, although total demands fall far short of the productive capacity of these foundries. Many units which rely almost entirely on the motor vehicle industry for their business continue to suffer from the decline in demands, which are barely sufficient to keep some of them occupied on a reduced working week. From collieries, steelworks, and railways the call for castings is also at lower levels, and there does not appear any prospect of an improvement in the near future.

The demand for builders' castings from the light foundries has declined due to seasonal influences and the curtailment in building. The light foundries supplying castings to the domestic equipment trade have been receiving better support lately and it is expected that this improvement will continue at least for the autumn and winter periods.

All consumers of pig-iron are well provided with supplies, and although outputs are on a reduced scale these are not fully absorbed and most producers hold appreciable stocks. Production of basic pig-iron is well below previous levels on account of the continued decline in demand from the steelworks, and a number of furnaces previously burdened for this grade are now out of production while others are working below capacity. Foundry irons are also plentiful and the present easy supply position does not warrant forward buying. The uncertainty of trade is no inducement to the building up of stocks at the foundries. Fairly good demands continue to be made for the low phosphorus irons by the engineering and speciality foundries, which are also consuming reasonable tonnages of hematite and some refined irons. Demands for the high phosphorus irons have recently shown some improvement, with the better trade at some of the light foundries.

The foundries are able to obtain the scrap they require as there is no shortage in supplies, apart perhaps from some special grades. They are also well supplied with foundry coke, ganister, and limestone.

Most of the re-rollers continue to be short of work and demands for their products are moderate. There is no improvement in the call for small bars, light sections, and strip, and in the case of reinforcing rods, which were previously in heavy demand, present requirements are on a lower scale. There is only a moderate call from the steelworks for supplies of steel semis, and only those tonnages required for current consumption to implement the work on hand are being specified. Mild steel semis are very plentiful and carbon and alloy steels are also more easily obtainable. Arisings at the steelworks of defectives and crops are not now so readily accepted by the re-rollers.

Non-ferrous Metals

Tin has become a difficult market to assess. Ever since the International Tin Council's buffer stock was exhausted the general feeling was that it would only be a matter of time before the price in London went up to £1,000 a ton. However, after going very near this level the price has gradually but persistently receded while supplies became easier and easier. The strike at the Steel Company of Wales, Limited, was largely responsible for reversing the downward trend of UK stocks, but there appears to be no urgency about building them up again. In fact, a falling off in demand for tinplate is reported from the Continent despite the industrial activity there and much the same comment is true of the demand position in this country and in the United States. The US price is fairly steady around $1.22 a pound.

Copper has been a steady but somewhat dull and featureless market both in London and in New York. In London the market has been in receipt of influential support, but a better demand has been noticed from the Continent. At present the outlook appears to be that present price levels will be held for the rest of this year in the absence of any particular news either adverse or favourable. The US quotation is unchanged at 31 cents a pound.

Zinc is a much better market in New York than in London. In the US demand has been consistently good recently and this raised the price in two stages from 11½ cents to 12 cents a pound. Consumer demand in the UK has also improved and the price has kept steady aided by continental activity. It is felt in most quarters that the recent low prices discounted virtually all the known adverse features. The LME price is fairly steady around £72 a ton.

Lead has been helped by the activity in zinc and in the US the price has been raised by ½ cent to 10¾ cents a pound. Yet the basic fact of world oversupply remains, demand is expected to fall off once more and the outlook must still be considered bleak. The LME price is hovering around £60 a ton.

Scottish Consortium for Poland

Six leading Scottish industrial firms have formed an association to develop trade with East European countries. Directors of the companies involved—Imex Engineering, Limited, G. & J. Weir, Limited, Motherwell Bridge & Engineering Company, Limited, North British Locomotive Company, Limited, Brown Brothers, Limited, and Bruntons, Limited, Musselburgh—leave London for Poland this week.

They have agreed to act on a consortium basis so that they can quote for complete plants which may be required. Each company will also investigate individual trade possibilities. Imex Engineering, Limited, are organising this visit in collaboration with Scottish Council (Development and Industry), Board of Trade, and the Polish Legation in London. During their week's stay in Warsaw the group will have meetings at the Polish Ministry of Foreign Trade and with individual Polish foreign trading corporations in Warsaw and Katowice.

MR. T. BROWN, MANAGING DIRECTOR, of Sheepbridge Engineering Company, Limited, Chesterfield, presented gold watches to 48 long serving employees, in appreciation of 25 years' service with the company, which was made at the annual dinner, in the works dining-hall.

Correction: Attention has been drawn to a misquotation of title in connection with an announcement of a new company being formed to promote research into the development of fuel cells, appearing on page 622 of November 16 issue. The three British companies promoting the new concern (Energy Conversion, Limited) are British Petroleum Company, Limited, British Ropes, Limited, and Guest Keen & Nettlefolds, Limited, the last-named being incorrectly quoted. Apologies are made to all concerned.

Current Prices of Iron, Steel, and Non-ferrous Metals

(Basis prices, delivered unless otherwise stated. Prices following side headings marked* are subject to an increase of 1 per cent. under Iron and Steel Board Price Determination, 1961, No. 2.)

December 6, 1961

PIG-IRON

*** Foundry Iron.**—No. 3 IRON, CLASS 2, 10-ton lots or over, Middlesbrough, £21 17s. 0d.; Birmingham, £21 9s. 3d.

*** Low-phosphorus Iron.**—Over 0.10 to 0.40 per cent. P, 10-ton lots or over, £23 5s. 0d., delivered Birmingham; £23 10s. 0d., delivered Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 6s. 6d.; South Zone, £25 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.; North Zone, £26 6s. 6d.; South Zone, £26 9s. 0d.

*** Hematite.**—Si less than 2 per cent, S. & P. over 0.03 to 0.05 per cent., 10-ton lots or over: N.-E. of England (local iron), £23 19s. 0d.; Scotland (Scotch iron), Zone S.1, £24 5s. 6d.; Sheffield, £25 9s. 0d.; Birmingham, £25 13s. 0d.; South Wales (Welsh iron), £23 19s. 0d.

*** Basic Pig-iron.**—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leicestershire in 10-ton lots or over.

FERRO-ALLOYS

(per ton unless otherwise stated, delivered)

Ferro-Silicon (6-ton lots and over).—45 per cent. Si, £45 0s. 0d. to £48 0s. 0d., scale 15s. 0d. per unit, lumpy, 75 per cent. Si, £62 10s. 0d. to £66 10s. 0d., scale 15s. 0d. per unit, lumpy.

Ferro-vanadium.—50/60 per cent., 22s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 14s.1d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £287 0s. 0d.

Ferro-tungsten.—80/85 per cent., 9s. 1d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 12s. 1d. per lb. of W.

Ferro-chrome (6-ton lots and over, lumpy).—4/6 per cent. C, £80 10s. 0d. to £84 10s. 0d., basis 60 per cent. Cr scale 27s. 0d. to 28s. 6d. per unit; over 6 per cent. C, £79 0s. 0d. to £82 10s. 0d., basis 60 per cent. Cr, scale, 27s. 0d. to 28s. 6d. per unit; 2 per cent. C,* 1s. 8d. to 1s. 11d. per lb. Cr; 1 per cent. C,* 1s. 8d. to 1s. 11½d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr.; 0.10 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.06 per cent. C,* 1s. 10½d. to 2s. 1d. per lb. Cr. * Average 68-70 per cent.

Metallic Chromium.—98/99 per cent., 6s. 9d. per lb.

Metallic Manganese.—94/96 per cent., carbon-free, £275 0s. 0d.; 96/98 per cent., £285 0s. 0d.

Ferro-columbium.—65/67 per cent. Cb + Ta, 19s. 0d. per lb., Cb + Ta.

Ferro-manganese (Standard).—78 per cent., £58 10s. 0d.

SEMI-FINISHED STEEL

*** Re-rolling Billets, Blooms, and Slabs.**—BASIC: Soft u.t., 100 tons and over, £31 15s. 6d.; tested, 0.08 to 0.33 per cent. C, 100 tons and over, £32 5s. 6d.; hard (0.41 to 0.60 per cent. C), 50 tons and over, £33 17s. 0d.; silico-manganese, 50 tons and over, £42 16s. 6d.; free-cutting, 50 tons and over, £35 4s. 6d. SIEMENS MARTIN ACID (50 tons and over): Up 0.25 per cent. C; £40 11s. 0d.; silico-manganese, £43 4s. 0

*** Billets, Blooms, and Slabs for Forging and for Stamping** 50 tons and over).—BASIC: Soft, up to 0.33 per cent. C, £37 0s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £38 2s. 6d.; acid, up to 0.25 per cent. C, £41 14s. 0d.

FINISHED STEEL

*** Heavy Plates and Sections** (50 tons and over).—Ship plate (N.-E. Coast), £40 7s. 0d.; boiler plates (N.-E. Coast), £42 17s. 0d.; floor plates (N.-E. Coast), £41 16s. 0d.; angles (N.-E. Coast), £38 1s. 6d.; joists (N.-E. Coast), £37 17s. 6d.

*** Small Bars, Sheets, etc.**—Rounds and squares, under 3 in., and flats 5 in. wide and under, untested soft basic, 50 tons and over, £39 1s. 0d.; under 10 tons to 4 tons, £40 18s. 6d.; under 4 tons to 2 tons, £41 3s. 6d.; hoop and strip, coils, 100 tons and over, £38 0s. 0d.; uncoated strip mill coils, hot rolled, under 3 mm. to 12g., 25 tons to under 50 tons, £43 16s. 0d.; black sheets (hand mill), 24g., 10 tons and over, £57 14s. 6d.; galvanized corrugated sheets, 24g., 10 tons and over, £67 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £67 16s. 0d.; nickel-chrome, £100 18s. 0d.; nickel-chrome-molybdenum, £113 11s. 0d., in lots of 25 tons and over.

NON-FERROUS METALS

Copper.—Cash, £228 15s. 0d. to £229 0s. 0d.; three months, £228 0s. 0d. to £229 0s. 0d.; settlement, £229 0s. 0d.

Copper, Tubes, etc.—Solid-drawn tubes, 2s. 2¼d. per lb. rods, 243s. 6d. per cwt. basis; 20 s.w.g., 278s. 6d. per cwt.

Tin.—Cash, £952 0s. 0d. to £953 0s. 0d.; three months £952 0s. 0d. to £953 0s. 0d.; settlement, £953 0s. 0d.

Lead (Refined Pig).— First half December, £60 2s. 6d. to £60 5s. 0d.; first half March £61 5s. 0d. to £61 7s. 6d. settlement, £60 5s. 0d.

Zinc.—First half December, £70 7s. 6d. to £70 10s. 0d., first half March, £71 10s. 0d. to £71 12s. 6d.; settlement; £70 10s. 0d.

Zinc Sheets etc.—Sheets, 15g. and thicker, all English destinations, £109 5s. 0d., rolled zinc (boiler plates), all English destinations, £107 0s. 0d.; zinc oxide (Red Seal); d/d buyers' premises, £85 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes 1s. 9¾d. per lb.; sheets to 10 w.g., 195s. 6d. per cwt.; wire, 2s. 8¼d.; rolled metal, 195s. 6d. per cwt.

Brass (Brazing).—BS1400, SCB2, £176; SCB3, £172.

Brass (High Tensile).—BS1400, HTB1, £195; HTB2 £212; HTB3, £226.

Gunmetal.—BS1400, LG2, £209; LG3, £219; G1, 1½% £278; G1 ½% £294.

Phosphor Bronze.—BS1400, PB1 (AID released), £312; PB4 £298; BS1400, 90/10/1%, £299.

Leaded Phosphor Bronze.—BS1400, LPB1, £233.

Phosphor Bronze Strip, etc.—Strip, 300s. 3d. per cwt.; wire, 4s. 2d. per lb.; rods, 3s. 4¾d.; tubes, 3s. 4¾d.; chill cast bars, solids 3s. 5d.; cored, 3s. 6d. (CHARLES CLIFFORD LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11¾d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4¾d.; special quality turning rod, 10 per cent., ¼ in. dia., in straight lengths, 4s. 3¾d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 2¼d. to 2s. 3d. per lb.; Antimony, English, 99 per cent., £230 0s. 0d. Quicksilver, ex-warehouse, £59 0s. 0d. Nickel, £660 0s. 0d. Aluminium, ingots, £186 0s. 0d.; aluminium bronze (BS1400), AB1, £238 AB2, £245.

Translation Services

From amongst the most recently published lists of translations available from the Iron & Steel Institute (4, Grosvenor Gardens, London, S.W.1), the following have been selected as being of interest to founders. The price quoted is that for single copies, postage extra, there being reductions for quantities ordered. Readers writing for translations, or for further information, should mention this JOURNAL when doing so.

BISI 2450 MEASURING, REGULATING, AND CONTROL EQUIPMENT FOR TOTAL BLAST-FLOW AND EQUAL DISTRIBUTION OF BLAST TO THE VARIOUS BLAST-INLETS OF THE BLAST-FURNACE. Lorich, H. *Conti Elektro Berichte*, 1961, 7, Jan./Mar., 23-33.

BISI 2470 NEW DEVELOPMENTS IN THE REGENERATION OF USED PICKLING BATHS. (From French.) Labergère, G. *Met. Constr. Mécan.*, 1959, *91*, July, 541-543, 547; Sept., 673.

BISI 2475 STRUCTURE AND PROPERTIES OF IRON AND STEEL SLAGS. (From German.) Röntgen, P., *et al.* II—Measurements of viscosity of melts of the systems ferrous oxide—lime—silica and ferrous oxide—lime—alumina—silica. (With bibliog., 47 refs.) *Erzmetall* (*Z. Erz. Met.*), 1960, *13*, Aug., 363-373.

BISI 2491 A CALCULATING INSTRUMENT FOR SPECTROCHEMICAL ANALYSES. Kaiser, H. *Spectrochimica Acta*, 1961, *4*, 351-365.

BISI 2494 FATIGUE PROPERTIES OF S.G. IRON. (From German.) Motz, J. *V.D.I.-Berichte*, 1961, (49), 43-46.

BISI 2498 ELECTROSLAG REMELTING—A NEW, EFFECTIVE MEANS OF IMPROVING THE QUALITY OF STAINLESS STEELS AND ALLOYS. Medovar, B. I. Stainless Steel Symposium, Prague, 1961, Preprint No. 11, 19 pp.

BISI 2370 SPECTROGRAPH FOR THE ANALYSIS OF MOLTEN METAL AND SLAG. (Short description of immersion spectrograph developed at Magnitogorsk.) (From Russian.) Kustanovich, I. M. *Fiz. Spornik L'vovsk univ.*, 1958, *vypusk 4*, (9), 451-452. (£1.) (*Abstracts Journal, Metallurgy*, 1959, (11/12) No. 413; (*Referatyvnyi Zhurnal Metallurgiya*, 1959, (11), No. 25187).

BISI 2412 METHODS OF EXTRACTING DUST FROM GASES. (From German.) I—Dry-dust extraction. II—Wet methods. III—Electrostatic methods. *Aufbereitungs-Technik*, 1960, Oct., 429-435; Dec., 518-527; 1961, June, 241-249. (£10.) The three methods are reviewed in detail, with descriptions of apparatus; bibliographies are given (41, 19, 28 refs).

BISI 2469 OPERATIONAL EXPERIENCE WITH A NEW VACUUM SPECTROMETER. (From German.) Dickens, P., *et al.* OPERATING DIFFICULTIES WITH A VACUUM SPECTROMETER. (With discussion.) Piper, E., and H. Kern. *Arch. Eisenh.*, 1961, *32*, June, 369-373; 376-377. (£5.) Operational requirements in large steelworks laboratories. Description of the source unit, spectograph and measuring console of the "Polyvac E 600" vacuum spectrometer. Industrial operation. Reproducibility of the measured values. Accuracy of the individual determinations. Exceptions. Conclusions. Oxygen content of the flushing argon in vacuum spectrometers, and testing of same. Difficulties due to contamination of the front lens, and methods of eliminating them. (Author's summaries.)

BISI 2482 INTRODUCTION OF ELECTRO-SLAG WELDING INTO THE MANUFACTURE OF WELDED CAST CONSTRUCTIONS. (From Russian.) Zaitsev, Yu. N., *et al.* Vnedrenie Novykh Sposobov Svarki v *Promyshlennost'* 1959, (2), 5-16. (£5 10s.)

HB 5253 TECHNOLOGY OF INOCULATION OF CUPOLA IRON WITH A CERIUM ALLOY. Talanov, P. I., and N. I. Astafurova. *Izvest. VUZ-Chern. Met.*, 1961, (5), 177-183.

Correction of Prices

BISI 2365 CONTROL DEVICE FOR THE ELECTRIC CURRENT IN STEEL MELTING ARC FURNACES. (From Russian.) Svenchanskii, A. D. Vestnik Elektroprom., 1960, Aug., 23-26. The price of this translation, announced in the JOURNAL, Oct. 26, p. 530, as £5 5s. should be £3 5s.

COCHRAN & COMPANY, ANNAN, LIMITED, have acquired the exclusive UK manufacturing rights for the Steinmuller system of evaporative cooling as applied to open-hearth, re-heating and various other types of furnaces.

MR. C. F. HURST, president of the Sheffield and District Works' Sports Association, made the annual presentations of the Balfour and Atherton Trophies, which go to the clubs with the greatest average number of points in team competitions, at the Association's annual dinner. Padley & Venables, Limited, won the Balfour Trophy, and Geo. Bassett & Company, Limited, the Atherton Trophy.

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Company News

Iscor's Record Output

For the first time in the history of the South African Iron & Steel Industrial Corporation, Limited (Iscor), annual ingot steel production exceeded the 2,000,000-ton mark in the financial year ended June 30, 1961. During the year the two works produced 2,212,244 ingot tons. It is only nine years ago that the Corporation for the first time produced more than 1,000,000 ingot tons a year. The net sales value of all products sold during the financial year amount to R.112,516,424 (about £66,250,000), compared with R.116,029,392 (about £58,000,000) for the previous year.

In his statement with the annual report Dr. F. Meyer, chairman, said that these figures included the export to overseas countries and African territories of 85,342 tons of steel, 62,275 tons of pig-iron, and 2,565 tons of coke oven by-products.

The total supply for the year of rolled and drawn steel products from local and overseas sources was estimated at about 1,892,000 tons, an increase of 216,000 tons over the adjusted figure of 1,676,000 tons last year, or 13 per cent. more. Of this tonnage producers in the Republic supplied 90 per cent., Iscor's share being 76 per cent.

During the year the Corporation's iron ore mines despatched 2,888,040 tons of ore to the works at Pretoria and Vanderbijlpark. Consumption of coking coal at the two works came to 2,471,328 tons, while an additional 384,501 tons of non-coking coal were used mainly for power generation and gas-producing purposes. The liquid iron production reached a peak of 2,011,782 tons—about 17.5 per cent. more than in the previous financial year.

Winget/Gloucester Wagon Merger

Directors of Gloucester Railway Carriage & Wagon Company, Limited, are entirely satisfied that a merger with Winget, Limited, manufacturers of concrete machinery and contractors' plant, of Rochester (Kent), "is infinitely to be preferred to a liquidation," and recommend acceptance. In the formal offer it is stated that the net assets of Gloucester Wagon, after adjustments, would be equivalent to about 16s. 9d. per 10s. ordinary unit, which might be improved upon to the extent of 1s. or so in the event of a liquidation over two or three years.

Referring to a claim by a Gloucester Wagon shareholder that "even liquidation could not fail to be more advantageous than the Winget offer as it is impossible to perceive how a liquidation could produce less than 20s. per unit," it is pointed out that the shareholder is not in possession of all the facts.

J. H. Fenner & Company, Limited, power transmission engineers and manufacturers, of Hull—Trading profit, etc., rose to £932,656 (£909,223), and the dividend is increased to 15 per cent. (12 per cent. equivalent).

Toledo Woodhead (Springs) Limited, manufacturers of laminated and coil springs, and spring washers, of Sheffield—The year ahead should see the beginnings of a substantial increase in turnover and a rise in profitability, says the chairman, Mr. Frank Woodhead.

Tecalemit, Limited, lubrication, hydraulic, and filtration engineers, of Brentford (Middx)—As forecast, a final dividend of 12 per cent., making 18 per cent. for the year to July 31, 1961, is recommended, as previously. Net profit is £344,839 (£298,359). The final dividend is not payable on the new shares which resulted from the recent one-for-four rights issue.

Birfield, Limited, holding company for engineering concerns, of London, W.1—Group sales expanded to £29,810,000 (£26,860,000) in the year to July 31, 1961, and the profit, before tax, rose to £3,374,402 (£2,638,311). A second interim dividend (in lieu of a final) of 5 per cent. is declared, making 10 per cent. as forecast, against a total equivalent to 8½ per cent.

Cochran & Company, Annan, Limited, boiler makers and engineers, of Annan (Dumfriesshire)—A good level of invoicing is being maintained, says the chairman, Sir Robert Adeane, and is likely to continue at any rate until March 31, 1962. The last quarter of the current year will become increasingly dependent on new orders, but, he adds, results should be materially better than last year.

Charles Churchill & Company, Limited, machinery and tool merchants, of Birmingham—The company announces that the Churchill Machine Tool Company, Limited, manufacturers of precision grinding machines, of Altrincham (Ches), following its acquisition by the Birmingham Small Arms Company, Limited, has terminated the sales agreement with Charles Churchill from the end of this year.

Glacier Metal Company, Limited—Profits for the first eight months of the company's current financial year show an "appreciable improvement" over those of the corresponding period of the previous year, the directors state. The interim dividend is maintained at 5 per cent. in respect of the year to February 28, 1962. But for the Chancellor's ruling, serious consideration would have been given to paying a higher interim.

German Scrap Trade hit

German scrap merchants are reported to have made a request to the High Authority of the ECSC for permission to export scrap to third countries. The High Authority is studying the general development of the scrap market.

In Germany, it is reported from Düsseldorf, there was a further deterioration in demand at the beginning of November and prices were again reduced. The current price for heavy steel scrap (quality No. 11) is DM 133 to 137 (£11 17s. 6d. to £12 4s. 8d.) at Essen. For exports to Italy, the price of heavy steel scrap has fallen to DM 153 to 155 (£13 13s. 3d. to £13 16s. 9d.) delivered German frontier, as trade has been particularly affected by Italian purchases in the United Kingdom.

The Italians are reported to have bought 40,000 tons of turnings and baled scrap at a price of $31 (£11 1s. 5d.) c.i.f. Genoa.

Brockhouse Group's Strong Position

Chairman of J. Brockhouse & Company, Limited, dropforgers, trailermakers, ironfounders, etc., of West Bromwich, Mr. John Brockhouse says that the company is in a stronger position than ever before and further improvements in profitability and steady expansion during the next few years can reasonably be expected. The directors are considering what steps to take to establish the group in the Common Market.

For the year to September 30, 1961, the group had a record net trading profit of £1,701,297 (£1,479,038). To mark the company's 75th anniversary, reached this year, the annual report and accounts are published as a special illustrated brochure which also records something of the firm's background and achievements.

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Pig-iron and Steel Production

Statistical Summary of September, 1961 Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table 1 summarizes activities during recent months. Table 2 gives production of steel ingots and castings in September, and Table 3, weekly average production of finished steel in August. Table 4 gives the production of pig-iron and ferro-alloys in September, and furnaces in blast. (All figures are weekly averages in thousands of tons.)

TABLE 1.—*Iron and Steel Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100.			Iron-ore output.	Imported ore used.	Coke sent to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	Iron and steel.	Coal.[1]	Basic materials.[2]						Imports.[3]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[4]
1959	340	496	477	286	244	210	242	208	7	388	291	2,244
1960	339	505	482	329	319	264	303	243	24	467	361	2,702
1961—June ..	341	520	479	326	298	249	297	233	5	447	340	2,679
July ..	343	520	478	312	270	238	277	196	7	380	311	2,596
Aug.[5]	343	520	480	305	264	226	265	163	5	338	298	2,689
Sept.	343	520	479	293	267	220	261	210	6	400	324	2,537

TABLE 2.—*Average Weekly Production of Steel Ingots and Castings in September.*

District.	Open-hearth.		Bessemer and LD.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derbys, Leics, Notts, Northants, and Essex ..	—	3.7	10.8 (basic)	2.2	0.1	15.5	1.3	16.8
Lancs (excl. N.-W. Coast), Denbighs, Flints, and Ches	1.2	35.5	—	4.8	0.3	40.5	1.3	40.5
Yorkshire (excl. N.-E. Coast and Sheffield) ..								1.3
Lincolnshire	—	44.6	—	—	0.1	44.5	0.2	44.7
North-East Coast	0.6	75.0	—	1.8	0.4	75.7	2.1	77.8
Scotland	0.4	38.6	—	3.6	—	40.2	2.4	42.6
Staffs, Shrops, Worcs, and Warwicks	—	23.1	—	4.7	0.7	26.6	1.9	28.5
South Wales and Mon	1.8	65.8	19.1 (basic)	0.6	0.1	87.0	0.4	87.4
Sheffield (incl. small tonnage in Manchester) ..	8.4	31.2	—	14.0	0.3	52.0	1.9	53.9
North-West Coast	0.1	—	5.8 (acid)	0.8	—	6.5	0.2	6.7
Total	12.5	317.5	35.7	32.5	2.0	388.5	11.7	400.2
August, 1961[5]	6.7	272.1	36.8	21.4	1.4	330.2	8.2	338.4
September, 1960	12.6	304.8	37.1	34.2	2.3	469.0	12.0	481.0

TABLE 3.—*Deliveries of New Non-alloy and Alloy Finished Steel.*

Product.	1959.	1960.	1960.	1961.	
			Aug.[5]	July.	Aug.[5]
Non-alloy steel:					
Ingots, blooms, billets, and slabs[6]	5.1	5.6	4.1	6.4	4.8
Heavy rails ..	6.8	8.7	8.2	7.1	6.1
Sleepers	0.6	0.8	0.6	1.8	0.2
Fish and soleplates	0.4	0.6	0.5	0.4	0.4
Plates, 3 mm. thick and over ..	43.1	52.9	48.2	41.9	43.4
Other heavy prods.	41.2	53.1	41.9	45.1	35.9
Ferro-concrete bars	9.6	12.0	9.0	13.0	7.4
Wire rods	23.5	28.6	23.5	25.5	16.2
Arches, etc. ..	7.8	7.9	6.6	7.2	5.3
Other light sections	33.0	41.3	31.6	36.3	24.2
Bright steel bars ..	7.6	9.7	7.6	9.1	6.3
Hot-rolled strip ..	27.4	33.1	23.6	29.0	18.2
Cold-rolled strip ..	8.0	10.0	7.6	8.3	5.1
Sheets, incl. coated	47.0	53.5	52.2	45.7	41.7
Tinplate	20.9	22.4	17.4	22.6	14.0
Blackplate ..	0.7	0.9	0.7	0.8	0.4
Tubes up to 16 in. ..	20.6	23.8	15.3	23.9	14.9
Tube fittings, etc.	0.4	0.4	0.3	0.4	0.3
Tyres, wheels, axles	2.4	2.4	2.2	2.4	1.2
Forgings (excl. drop)	2.1	2.2	1.7	2.3	1.6
Steel castings ..	3.6	4.3	3.7	4.2	3.2
Tool steel	0.2	0.2	0.2	0.3	0.2
Total	312.0	374.4	308.7	333.2	251.0
Alloy steel	18.2	22.5	17.1	22.9	14.4
Total UK deliveries[7]	330.2	396.9	325.8	356.1	265.4
Add: Imported steel	7.1	19.1	21.1	3.9	4.4
	337.3	416.0	346.9	360.0	269.8
Deduct: Intra-industry conversion[8] ..	47.6	56.4	41.0	50.1	33.4
Total new material ..	289.7	359.6	305.9	309.9	236.4

TABLE 4.—*Production of Pig-iron and Ferro-alloys.*

District.	Furnaces in blast.	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.
Derbys, Leics, Notts, Northants, and Essex	17	—	17.8	20.9	—	38.7
Lancs (excl. N.-W. Coast), Denbighs, Flints, and Ches ..	8	—	23.3	—	2.3	25.6
Lincolnshire	9	—	40.7	—	—	40.7
North-East Coast ..	15	2.1	46.8	—	—	48.9
Scotland	6	1.0	18.3	2.0	—	21.3
Staffs, Shrops, Worcs, and Warwicks ..	4	—	8.5	0.3	—	8.8
South Wales and Mon	11	4.0	54.9	—	—	58.9
Sheffield	1	—	2.0	—	—	2.0
North-West Coast ..	6	15.3	—	0.5	—	15.8
Total	77	22.4	212.3	23.7	2.3	260.7
August, 1961[5] ..	81	20.8	220.0	21.8	2.3	264.9
September, 1960 ..	87	21.5	256.4	23.3	4.6	305.8

[1] The index for coal is now based on prices ruling on the last day of each month.

[2] Used in non-food manufacturing industries.

[3] Weekly average of calendar month.

[4] Stocks, mainly ingots and semi-finished, at the end of the year and months shown.

[5] Five weeks, all tables.

[6] Other than for conversion into any other form of finished steel listed.

[7] Includes finished steel produced in the UK from imported ingots and semi-finished steel.

[8] Material for conversion into other products also listed in this table.

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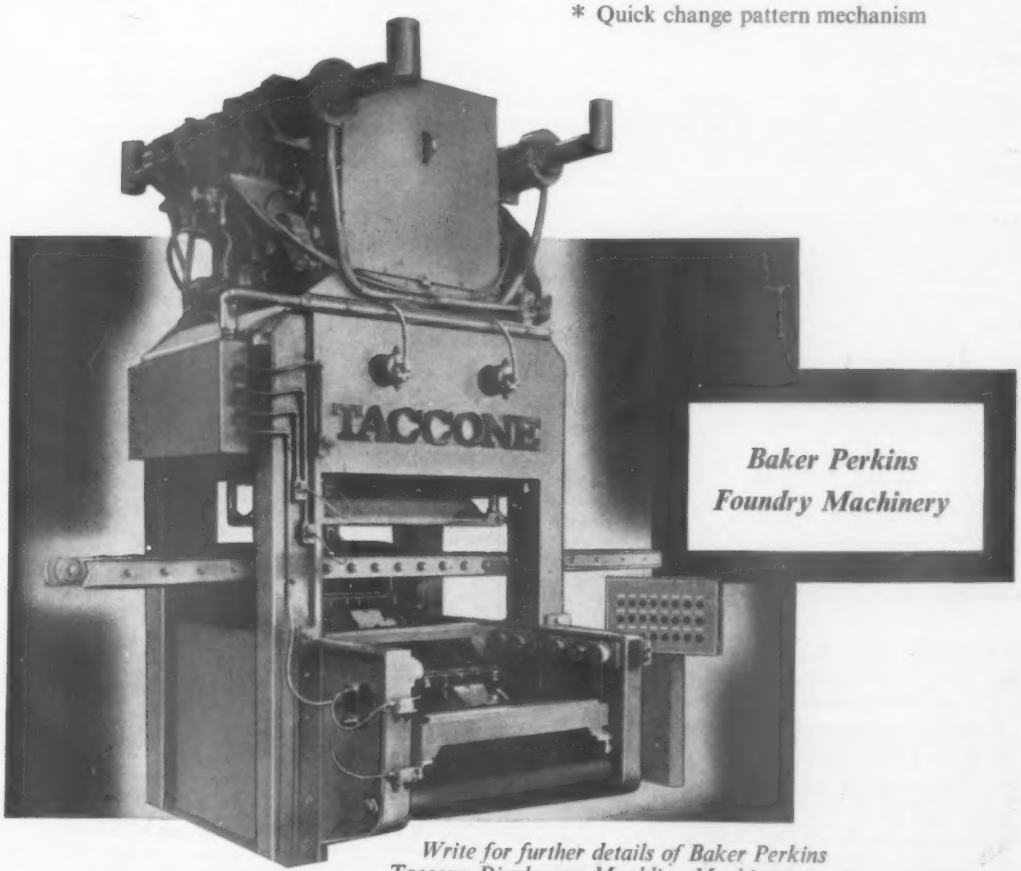

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FOUNDRY FOREMAN seeks position. 15 years' experience as senior foreman. Modern foundry practice—high quality ferrous, and non-ferrous castings. Jobbing, mechanised, metal control. Good Refs. Box FF221, FOUNDRY TRADE JOURNAL.

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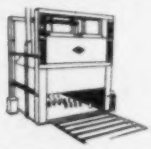
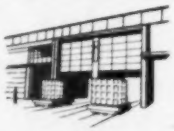

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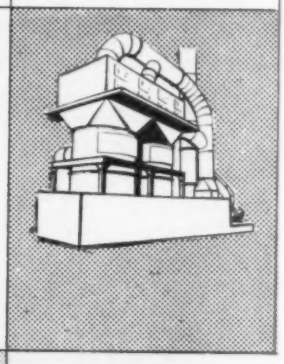

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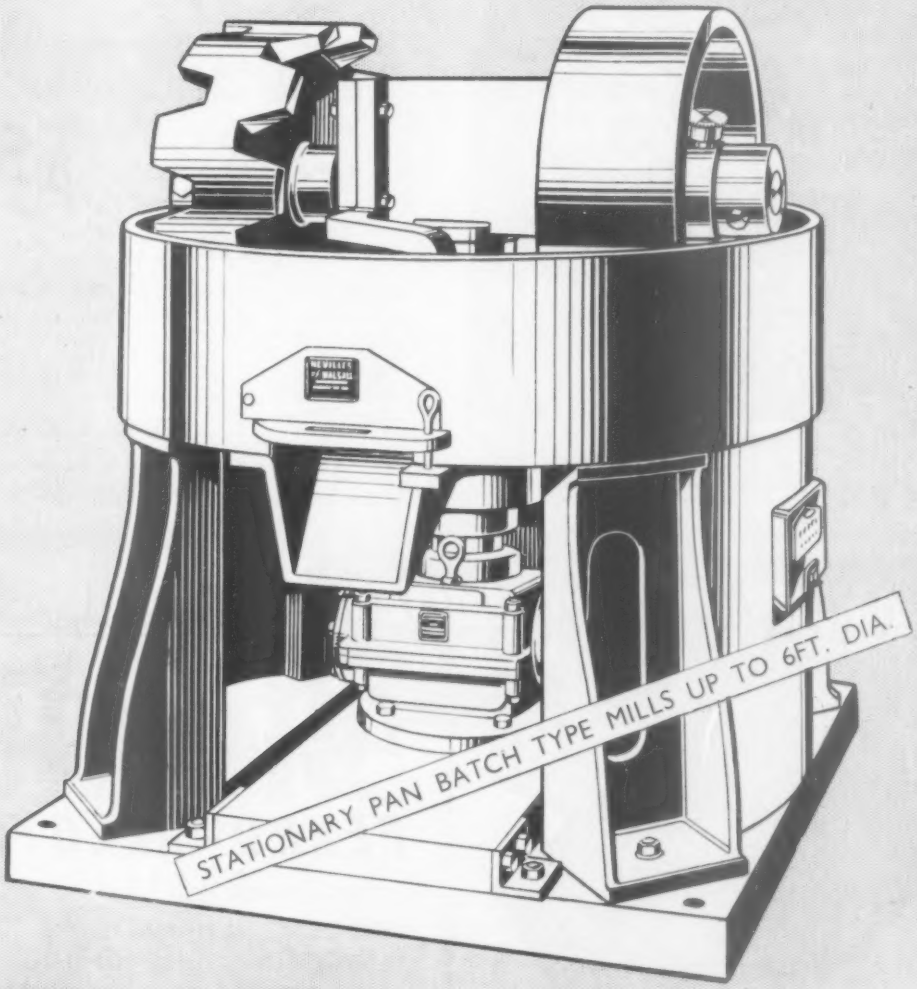

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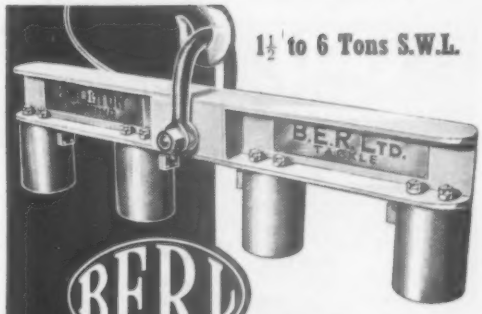

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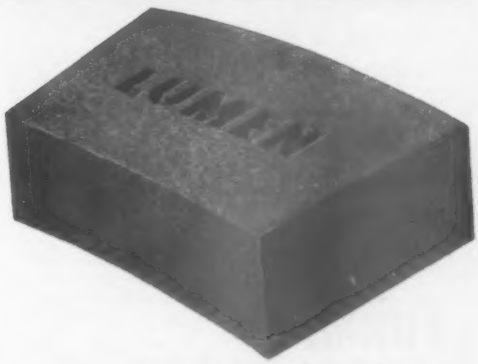

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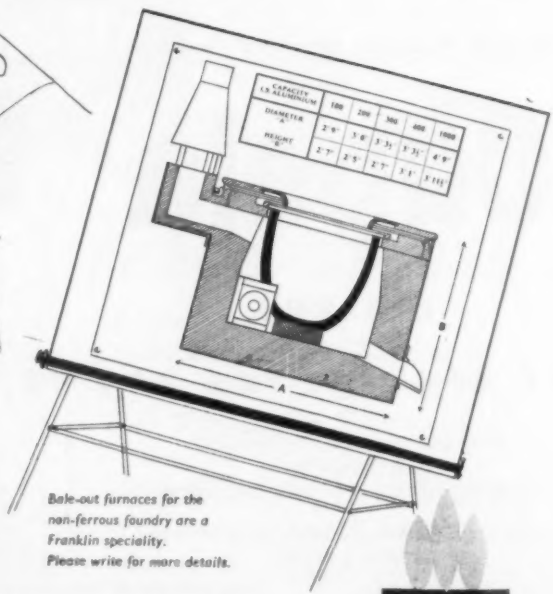

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Published by the Proprietors, Industrial Newspapers (Fuel & Metallurgical), Limited, John Adam House, 17/19, John Adam Street, London, W.C.2, and printed in Great Britain by Harrison & Sons, Limited, by Appointment to Her Majesty The Queen, Printers, London, Hayes (Middx) and High Wycombe.

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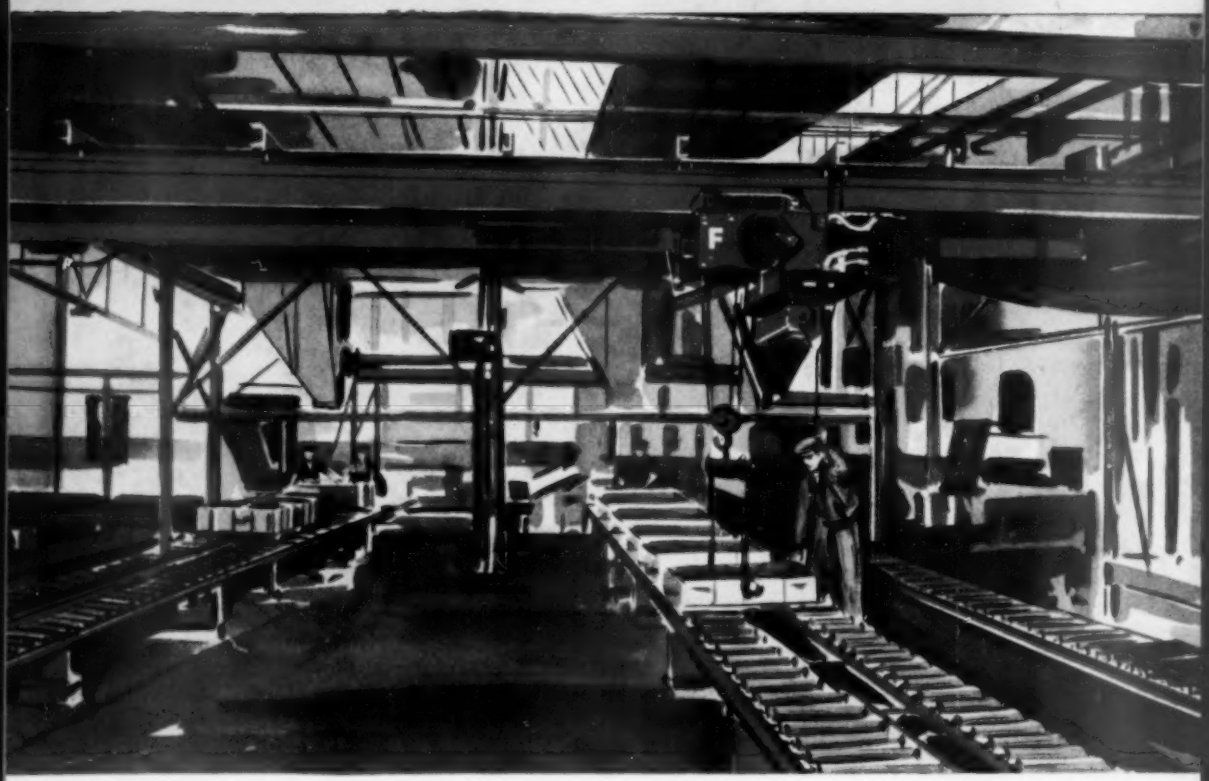
VOL. III
No. 2348
Registered at the G.P.O. as a Newspaper

DECEMBER 7, 1961
Offices: John Adam House, John Adam St., London, W.C.2

Single Copy 1/-. By Post 1/4. Annual Subscription, Home 52/-, Abroad 60/- (Prepaid)



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